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Electro-Therapeutical Practice

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ELECTRO-THERAPEUTICAL PRACTICE

A Ready Reference Guide for Physicians in the Use of Electricity and the X-Rays

TWENTY-SECOND EDITION

BY

CHAS. S. NEISWANGER, M. D.

President and Professor General Electro-Therapy Illinois School of Electro-Therapeutics; Chicago Hospital College of Medicine; Late Professor Electro-Therapeutics Chicago Post Graduate Medical School, Bennett Medical College and Illinois Medical College; Author of "Suggestions in Electro-Therapeutics"; Member Chicago Electro-Medical Society, Tri-State Medical Society, etc., etc.

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TO

MR. C. ALFRED SMITH,

MY FRIEND ALWAYS,

WHO TWENTY-THREE YEARS AGO MADE

THE FIRST EDITION OF THIS

BOOK POSSIBLE,

THIS VOLUME IS AFFECTIONATELY

DEDICATED.

PREFACE TO THE NINETEENTH EDITION.

Only a few years ago every line of "Electro-Therapeutical Practice" was based upon the actual experience of the author. Now, however, the subject is divided into so many specialties and the apparatus has become so varied and complicated that it becomes necessary—if the book is to embody *expert* work in every branch of electro-therapeutics—to seek *expert* advice from friends who have kindly offered their assistance.

The author wishes to acknowledge his indebtedness to that excellent surgeon, and great delineator of diseases of the Stomach and Intestines, Dr. Nelson H. Lowry, of Chicago, for his valuable assistance on Stomach and Intestinal Diagnosis.

And to my friend, Dr. T. D. Bristol, of Cleveland, Ohio, for his valuable aid in Diathermy and other high frequency modalities.

Also to my valued colleague for many years, Dr. M. C. Rice, who has ably assisted me from the inception of this work, I am especially indebted for the latest technic in Deep Roentgen therapy and citation of cases.

I am also indebted to various manufacturers of electrical apparatus for cuts and other data, amongst whom I desire to mention the Victor Electric Corporation, the H. G. Fischer Company, Burdick Cabinet Company, McIntosh Battery & Optical Company, and Wappler Electric Manufacturing Company.

To the many thousands of physicians, without whose support my work would have been in vain, I take this opportunity to express my sincere thanks.

No. 703 Marshall Field Bldg., Chicago, Ill.

BRARY

INTRODUCTION.

"Progress needs the brakeman, but the brakeman should not occupy all his time in putting on the brakes."

Yes, much progress has been made in the past decade in medicine, especially surgery, but some of the *brakemen* of the profession seem to be spending the best years of their lives trying to convince their few remaining patients that electro-therapy is a fad.

How prone we are to criticise that which we do not understand, or that which encroaches upon the domain we have marked out for ourselves. Why? Simply because we do not all see things alike, not having viewed them from the same standpoint. Difference of opinion, however, is helpful, otherwise we would never arrive at correct conclusions.

Like other things that have offered obstacles, electricity has more than once discouraged its adepts and only seems to shine with an occasional brilliancy. We seem to be living in the presence of ever dissolving facts, or what we once considered facts, but which our experience of today forces us to discard. This only goes to prove that electricity, like other branches of medicine, is not an exact science, and all the enthusiasm we may put in the subject does not make it more than a single remedial agent of very wide range.

Enthusiasm is, in all probability, the cause of the downfall of many a good therapeutic agent, because it not only hurts the remedy and those who use it, but begets adverse criticism from others of the profession, thereby preventing its legitimate use.

I have made a special study of this force from a therapeutic standpoint for many years, and while I find much to admire in its efficacy in the treatment of many pathological conditions—even to the point of becoming enthusiastic—I have never yet said to any patient, "Do not be operated upon, I will cure you with electricity."

We believe it is a conservative statement that there is scarcely a condition of disease but that electricity may be used in some form, either as an adjunct or a remedy, but we are forced to the conclusion that other remedies, which may not meet the indications as well, are employed because of a lack of knowledge of the therapy of electricity. While this is creditable from the standpoint that no remedy—especially if it be electricity—should be used without its therapy being known; it is deplorable to be forced to forego that which is best adapted to the case because it involves a little study.

If anything will do the work better, use it, but in view of the immense amount of reliable data at hand showing its remarkably beneficial effects upon various pathologic conditions, the true physician would be lax in his duty to his patients did he not study and use it.

The physician who uses galvanism intelligently in his practice soon drifts into gynecological work, because that current controls so admirably the pelvic diseases of women.

In genito-urinary practice the results obtained by myself and many others in the reduction of urethral strictures and the treatment of prostatic lesions, fully justify a continuance of the remedy and should court its elaboration by specialists along these lines.

The ordinary faradic battery will tell you accurately whether your case of paralysis is of cerebral or peripheral origin. Galvanism will assist you in making a prognosis by showing just how far degenerative changes have progressed in the nerve.

Nearly every physician throughout the country owns a faradic battery, but does he know or realize the number of emergency conditions to which it is applicable? Does he know that in cases of drowning, asphyxia and opium poisoning he can produce artificial respiration better and more certain by the use of induced currents than by the use of any other means and thus save all the manual labor usually required for such work? That the new born infant may be resuscitated quickly by the same means?

The observing physician who has watched the treatment of cases of neurasthenia, neuralgias, neuritis and hysteria, could not be other than profoundly impressed by the beneficial action of static electricity in these stubborn cases.

The uses of the *X*-ray in medicine and surgery are many and varied, and most of my readers are familiar with the literature on the subject. The longer I use it, however, the more care I exercise, for I have just begun to realize its danger both to patient and operator. The literature, as to its indications and the technique, is so diversified that it behooves all seekers after knowledge in this direction to exercise extreme care. Freund aptly remarks, "Radio-therapy must be learned practically under a skilled operator and not from books."

How like human nature it is to think we are right and those of contrary opinion wrong, but do not forget that it might be the reverse, and it is my earnest desire that the readers of the following pages may look kindly on my effort to induce them to view this subject from the standopint that "there is good in all."

CHAPTER I.

PROPERTIES OF ELECTRICITY.

In the study of electricity for therapeutic purposes physicians are prone to make several mistakes that are not conducive to its proper understanding. First, they expect too much from it, and are often disappointed when they discover that, like other therapeutic agents, it cannot be used outside a certain circumscribed field.

Second, they begin its study from the wrong end by buying an expensive and elaborate apparatus about which they know nothing—not even the manipulation of the switches—and expect to use it as a therapeutic agent without further knowledge, only to find it very potent for good or harm, and, while a very docile servant, a terrible master.

Third, the beginner is always apt to view the subject as something mysterious. We cannot properly study any subject from this standpoint, but must divest it of its mystery and study it as something that can be handled, controlled and utilized. The ancients never made much advancement in the study of natural phenomena because they surrounded it with mystery and superstition. With them the thunder was the voice of God in wrath, and the lightning was sent to destroy the wicked.

Twenty-five hundred years ago, Thales, the Grecian philosopher, one of the seven wise men, discovered electricity. In those days the sailors were accustomed to gather from the ocean a peculiar yellow substance that was beautiful and had intrinsic value, which they called "elektron"—the Greek name for amber. Thales discovered that, by rubbing this amber it would attract lighter bodies, much the same as we rub a glass rod with a silk handkerchief and pick up the pith ball. The Greek savant did not say, however, as we would today, that by rubbing the amber we made it a different potential from surrounding objects and they were thereby attracted to it, but he attributed to it a soul and said that by rubbing we gave it life. That was mystery, pure and simple, and we cannot wonder that it was five hundred years afterward before Pliny the elder absolutely discovered that there were other substances besides amber that behaved in this manner—sealing wax, vulcanite, etc. This is as far as the science of electricity advanced in 500 years, simply because its study was hampered by surrounding it with mystery.

Electricity is a natural phenomenon, and the only way to accomplish results either physical or therapeutical is to observe closely and try to interpret the language in which nature speaks to us. It took years of patient study and work for Galvani and Volta to arrive at conclusions, the result of which has been a permanent benefit to mankind and made their names famous for all time; and although we have apparently made much advancement in late years in the application of electricity for the alleviation of many human ills. it yet remains, as it were, a sealed book.

The apathy of physicians in regard to electricity for therapeutical purposes is not being able to measure the results at a glance; they are too apt to expect something phenomenal which, in reality, has never been the case with any great therapeutic agent, and why they should expect it from electricity is another unexplained mystery. Brown-Sequard, Koch and others have furnished splendid examples for the observation of those who would benefit mankind by one great stride in the therapeutical world.

Let us compare electricity with some of the other forces with which we think we are familiar and see how closely they are related. The latest and most plausible theory regarding electricity is, that it is a mode of motion or other manifestation of a very exceptional form of matter called *the ether*. Referring to some of the properties of this ether, Duff says:

(1) It permeates all bodies and pervades all known space, even to the most distant star.

(2) It is affected by the matter of bodies in which it is. It appears to be concentrated in it to an extent depending on the density of the matter. Ether thus bound differs from free ether in that it transmits short waves more slowly than long ones.

(3) It is continuous, not granular.

(4) Its density is to that of water as is unity to unity followed by twenty naughts (10^{20}), while its rigidity is one-billionth that of steel.

This ether then is electricity in a latent or passive state, but in order to convert it into energy it is necessary to destroy its equilibrium, and kinetic energy is generated when it seeks to restore that lost equilibrium, much the same as water when raised above its level can be made to do work by the pressure it exerts, e. g., a mill race.

If we take a rubber tube open at both ends and immerse it in a lake the tube will be filled with water, but we can do no work with it, although the tube is what we might call a *conductor*, because the water does not flow; but put a force pump at one end of the tube and cause a flow and the work that can be done will be in proportion to the pressure exerted by the pump.

A copper wire is strung up along the street on poles and although the wire is immersed, as it were, in electricity (ether) and is a good conductor of the same, we have no current or flow because the *electric level is not disturbed:* but put a force pump (dynamo) at one end of the line and we can do work in proportion to the *pressure* exerted by the dynamo, such as operating motors, electric lighting, etc.

A battery then is merely a machine or instrument for keeping up a difference in electric level and thereby causing a current of electricity to flow.

Light is only a transverse vibration of this same ether, the wave lengths being infinitesimally shorter than the other forces, the vibrations of red light being about 400,000,000 per second.

We know the laws that govern electricity just as well as we know the laws regulating light, heat, sound and gravitation, and when we observe that they are elucidated by a mathematical process, much of the mystery surrounding them is dissipated and we look upon them as cold facts capable of being demonstrated; but when we come to consider the fact that all animal and vegetable life is not only due to but dependent upon the electrical conditions that surround and are within them, is it not reasonable to suppose that we should be able to restore the equilibrium of the body (health) by supplying electricity from some outside source?

Althaus gives excellent reasons for believing that the work of the brain cell is of an electrical nature and compares the axons to conductors and their myeline sheaths as insulators, so that there is isolated conduction along the whole of fully matured nerve fibers, up to the point where they reach the peripheral or central terminations of the sensory organs or the muscles, where the myeline sheath disappears and the axons become naked, allowing of the free transmission of the current. Thus the axons of the neuron resemble the conducting cords of a battery.

In health the nerves are all in a state of vibration, due, in all probability, to the currents of electricity which traverse the body in every direction, and when a nerve loses its vibratory action its function is destroyed and degeneration commences.

Every conductor carrying a current of electricity, vibrates. Even the copper trolley wire that supplies the current to the street cars vibrates to such an extent that, in time, it can be broken like a piece of cast iron, its molecules having been so disturbed by the vibration.

If the nerves carry electrical currents, they vibrate and the rate of vibration is governed by the kind of current, therefore each nerve has its own rate of vibration and will only respond to that rate.

Light being a very rapid, transverse vibration of the ether, the optic nerve is so constructed that it responds to these vibrations or wave lengths and *we see.* The auditory nerve is so constructed that it responds to longer wave lengths and *you hear.* If it happened that the optic and auditory nerves both responded to the same vibration, then you could *see the sound* and would not need ears.

Other forces that held us spellbound in the past have lost their charm, but a certain poetry seems to pervade the subject of electricity that almost forbids its study from a standpoint of materiality. We think, however, it will not be difficult to demonstrate the simplicity of this force by commencing *at the beginning* or at the *right* end, giving simple illustrations, and avoiding the common fault of talking "over the head" of the reader.

The author would especially ask a careful consideration of the chapters pertaining to the physics of this force, and it shall be his endeavor to present this portion of the work in the plainest language possible, for he realizes fully that a good electro-therapeutist only becomes so by an intimate knowledge of the rudimentary physics.

CHAPTER II.

VOLTS—AMPERES—OHMS.

The *volt, ampere* and *ohm* are the first three measurements in electricity, and it is necessary for the physician to have a proper conception of them before he can hope to apply it rationally for therapeutic purposes.

Voltage is not electricity, but only one of the component parts of electrical energy, and although itself perfectly harmless, it becomes a dangerous factor under certain conditions. Voltage then is the pressure at which electricity is used and can be likened to the pressure in a steam boiler. We would not call the pressure in a boiler steam, and it would be evidently as improper to call voltage electricity. It is pressure. We then have:

Voltage = pressure = E. M. F. = E.

E. M. F. stands for "electro motive force" and is the best and at the same time the technical name for voltage, because it tells just what it is—the force that moves electricity. Wherever we see the letter "E" in electrical formula, it always means voltage.

If we take two *dissimilar* metals and plunge them into an exciting fluid they are acted upon differently by the fluid, and the greater this difference of action the greater the difference in electric level; the greater the difference in electric level the greater the voltage.

Suppose we immerse a piece of zinc and a piece of iron in an acid or other exciting fluid, the zinc and iron will be attacked by the fluid in nearly the same proportion, and the difference of potential between the two metals will be so small that the resultant voltage will be very little; but suppose the two metals to be zinc and carbon—the zinc is acted upon readily while the carbon is unaffected by the fluid, consequently these two metals give us the greatest difference of potential and a higher voltage is obtained by their use than by any other metals.

The volt then is the unit of electro-motive force (E. M. F.) and is about equal to the pressure exerted by one Daniells cell, which, although not a technical definition according to the present electrical standards, will serve the purposes of this work and is approximately correct.

Amperage is the *rate of flow* and is not to be confounded with voltage, for although each is a component part of electrical energy they serve an entirely different purpose. Voltage is that which *tends to move* current over a conductor, while amperage is *that which is moved.*

In most of the text books for physicians *amperage* is defined as *quantity*. This is obviously wrong, because we must not look upon electricity as a thing or entity, but a condition. Amperage, then, is only the *rate at which electricity flows* and that rate is governed entirely by the pressure or voltage. If I say I am giving my patient fifty milliamperes of current, I mean that a rate of flow of fifty milliamperes is maintained throughout the entire circuit, and consequently just that much is passing through the patient.

The water that pours over the falls of Niagara we might compare to the *amperage,* while the distance it falls we would call *voltage.*

The water in the river represents *amperage,* the swiftness with which it flows (caused by difference of level) the *voltage.* We may have a very large river flowing slowly or a small stream running swiftly, and just so we have electrical currents of high amperage and low voltage, or vice versa.

The ampere is the unit of current (C) and is just as much electricity as can be pushed through a resistance of one ohm by one volt pressure. The ampere being more current than can be used for therapeutic work, it is divided for the convenience of electro-therapeutists into 1,000 parts, called *milliamperes.*

The term *resistance* as used in an electrical sense does not differ in meaning than when the same term is used relative to the other forces and simply means that which opposes the passage of electricity through a circuit.

The *ohm* is the unit of electrical resistance (R) and is approximately equal to the resistance offered by a piece of copper wire 250 feet long and 1-20 inch thick. The resistance of wires or other conducting material vary directly as their length and inversely as their cross section, and also inversely as their conductivity, therefore a short wire offers less resistance than a long one, and a thin wire offers more resistance than a thick one of the same length; much the same as a large pipe will carry more water than a small one. Of the metals, pure silver is the best conductor, but copper so nearly equals it for all practical purposes that it is preferred. Platinum has five times the resistance of copper. Metals being the best conductors of electricity, any solutions of the salts of metals decrease the resistance, as for instance water containing in solution one part of salt (sodium chloride) conducts a hundred times better than ordinary water, and it is for this reason that we sometimes wet sponges and other electrodes with salt water—to increase their conductivity by decreasing their resistance. As resistance is quite an important factor, it will be considered more in detail in the chapter on electrical measurements.

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CHAPTER III.

GALVANISM—BATTERY FORMATION.

The galvanic current, sometimes called the *direct* or *continuous* current, is, for therapeutic purposes, generally produced by chemical decomposition—or is merely the conversion of chemical energy into electric energy. It must be remembered that while it is impossible to change matter from one form to another, it is easy to convert one manifestation of force or energy into another; as, for instance, heat energy may be converted into mechanical energy—a good example being the steam engine. It is well to also keep in mind the law of conservation of energy which teaches, "that there are no forces in nature to which the law of energy does not apply; the principle that the total energy of the universe is constant, no energy being created or destroyed in any of the processes of nature, every gain or loss in the form of energy corresponding precisely to a loss or gain in some other form or forms." This is the great fundamental principle of modern physics, and is just as applicable to electricity as any other force.

The fact is, then, that the electrical energy we utilize for the treatment of disease, if derived from a battery of cells, is generated entirely by the chemical decomposition that takes place within the cell, and if we expect to generate electricity for any purpose, we must have a consumption of the fuel that keeps up the chemical decomposition, and this fuel must of course be renewed as required, much the same as the stove which furnishes heat energy must be supplied with coal as needed.

Although the physician would not expect his stove to furnish heat without a renewal of fuel, yet how many there are who are attracted by the seductive advertisements of those who would furnish them a battery of 20 or 30 cells as large as a man's finger, that is *guaranteed to do heavy work for a period covering years.* This is no fault of the physician, because he has had no special training in this direction, but it has been very discouraging to the use of electricity in medicine, because all who use such apparatus are doomed to failure as far as absolute results are concerned.

About 130 years ago, Galvani, who was a professor of physics at Bologna, was experimenting upon the legs of frogs. It was quite a favorite experiment in those days to flay the frog legs and having suspended them by a cord, cause a spark from their crude static machines to jump into the lumbar nerves, causing the gastrocnemius to violently contract. It was considered very mysterious; a new form of life, as it were.

Galvani, after having prepared his frog legs one day, presumably to perform his experiments before his classes, hung them upon copper hooks that had been fastened into an iron balcony. In a little while he perceived a twitching in the muscles, much the same, only in a less degree, as would be caused by the static machine. The latter instrument was far away in the house and could not have caused the phenomenon. What caused the movement in the muscles of the frog legs?

Galvani never ascertained the cause and only went so far as to record his experiment, but to Volta, who, five years afterwards, discovered that the muscular contractions were due to the difference of potential between the two metals—the iron balcony and the copper hooks—we are indebted for the true birth of *galvanism.*

Volta at that time constructed what he termed the *crown of cups,* which consisted of a number of glass containers each being about two-thirds full of a saturated solution of common salt. Into each of the glasses he placed a strip of copper and a strip of zinc, then joined the zinc of the first glass, by a metallic conductor, to the copper of the second glass, until all were connected in a continuous chain. He then found that, by taking a wire from the last zinc and one from the first copper he was able to produce the movements in the frog muscle. The value of Volta's experiment will become apparent when we consider that, although more than 130 years have passed, we have not changed this arrangement in one iota, except to substitute carbon for the copper. This is what we now call connecting in *series,* and will be referred to later. A simple galvanic cell may be made by taking two coins—a silver quarter and a copper cent—and placing one on either side of the tongue. Nothing is perceptible until we bring the edges of the coins together, when we can both *feel* and *taste* a current of galvanism.

BATTERY FORMATION.

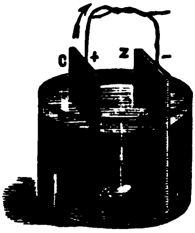


FIG 1.

The simplest form of a galvanic cell, as shown in Fig. 1, consists of a plate of carbon (c) and a plate of zinc (z) immersed in an exciting fluid. The chemical decomposition that takes place at the zinc makes it the generating plate and causes positive electricity to be generated there, and this flowing through to the carbon, which is of lower potential, is carried out of the cell through any conducting medium that may join the two elements together from the outside. (See direction of arrows.)

The manner of joining a number of cells together depends upon the kind of work required of them; as, for instance, when we wish to treat the human body, which offers a comparatively large resistance to the passage of the current, the cells must be connected in what is called *series* (Fig. 2), in order that we get a greater voltage.

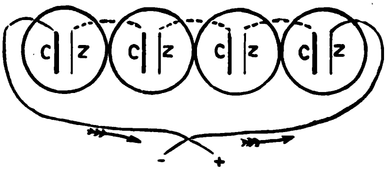


FIG 2.

To connect cells in series we join the *unlike* elements together by means of a wire or other good conductor; that is, the zinc of first cell with the carbon of the one following until all are connected in a continuous chain. *All galvanic batteries for therapeutic purposes are connected in this manner,* each cell added increasing the pressure or voltage of the circuit. If, however, the work we would accomplish requires a larger quantity or amperage and not so much voltage (the resistance to be overcome being small) such as heating platinum electrodes for actual cautery, then the arrangement must be entirely different, the *like* elements being connected together as in Fig. 3, which is called *multiple* or *parallel.*

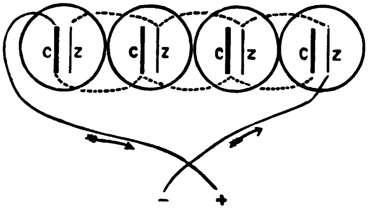


FIG. 3.

If each of these cells gave a pressure of one volt, and one ampere in quantity, then by the first arrangement (series) we have in the circuit *four volts* and one ampere, while in Fig. 3 (multiple) we have *four amperes* and one volt, or just the same as one cell with very large elements.

By multiplying the volts by the amperes in any circuit we obtain the number of *watts*.

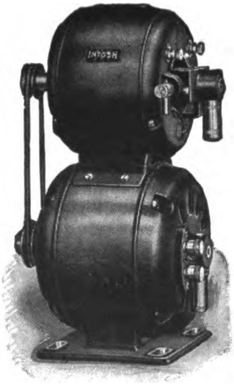
The watt is the unit of power and it takes 746 watts to make one horse power, by which it may be readily observed that the unit of power will be exactly the same, no matter whether we connect the cells in *multiple* or *series*. In Figs. 2 and 3, the number of *watts* being the same, the amount of work done by each will be equal, only different kinds of work.

It is rarely necessary to have a portable galvanic battery, for the reason that the galvanic current is not often used in emergency cases, and patients can come to the office for treatment if galvanism is to be used. If, however, a portable battery is required it should be supplied with one of the many forms of so-called *dry* cells connected in series. Twenty to thirty of such cells will ordinarily furnish all the energy required; they cannot, however, be recharged, but can easily and cheaply be replaced by new cells. Such a battery is cheap and has the advantage of being easily kept in order.

In the office or stationary form of battery—and such a one is always to be preferred unless practice is strictly confined to the country—we use some form of the Leclanche cell, in which the elements are zinc and carbon and the exciting fluid a saturated solution of ammonium chloride. The elements do not have to be taken out of the fluid in this form of cell, and they will do satisfactory work for a period of one year or more without renewal.

All battery cells are subject to what is called *polarization*, i. e., the deposition of bubbles of hydrogen upon the carbon element which will then become the generating plate and cause a current of electricity to flow from the hydrogen-covered carbon plate *toward* the zinc, thus partially neutralizing the original flow. While many methods are in vogue for preventing this, they only partially do so, but owing to the fact that the larger the surface of the carbon the longer time it takes to cover it with the hydrogen bubbles, it would be proper in selecting cells, especially those to be used in stationary or office batteries, to get those having the *largest carbon surface.*

The most convenient source of current supply for therapeutic purposes is the 110 volt *direct* lighting circuit. Many towns and cities, however, have only the *alternating* current for lighting purposes, and as this cannot be utilized for supplying therapeutic apparatus a small *direct* current generator giving a pressure of 110 volts, is operated by a suitable alternating current motor, and will be found very satisfactory in use. Such an arrangement is shown in the accompanying illustration.



CHAPTER IV.

ELECTRICAL MEASUREMENTS.

About the year 1827 Dr. George Ohm gave us the law that bears his name and which forms the basis of all electric measurements, viz.: "The strength of the current passing through any part of a circuit varies directly as the difference of potential between its elements, and inversely as the resistance of the circuit itself." This may be expressed by the following equation where E represents the electro-motive force of the battery in volts, C the current in amperes and R the total resistance in the circuit in ohms:

$$C = \frac{E}{R}$$

or, the current is equal to the voltage divided by the resistance.

A very simple illustration, one that is in common use, will serve to elucidate Ohm's law. The water that flows through the nozzle of an ordinary syringe will be directly proportioned to the force with which it is urged forward by the piston; this force would correspond to the electro-motive force or voltage. The friction will represent the resistance in the circuit. Now, if we divide the former by the latter we have the quantity of water which flows through the nozzle in a given time, representing the strength of current. If the nozzle of the syringe were longer (the pressure being the same) less water would flow, or if the hole in nozzle were decreased in size the same thing would happen, because in each case the resistance is increased. This being compared with electricity would imply that the longer or thinner the conductor the greater the resistance and consequently the less current would flow.

It must now be understood that there is a definite relationship existing between these three factors, voltage, amperage and resistance, and that we cannot destroy this relationship. If two electrodes from an acting galvanic battery be placed upon the body and a certain amount of *pressure* (voltage) be turned into the circuit, a definite rate of current flow (amperage) will be established. If now we move the electrodes to another part of the body where the *resistance is greater,* the same amount of voltage will not maintain the same current flow, but in order to obtain the original amperage we must either increase the *pressure* or decrease the *resistance.* So if we gain in one of these factors it must be at the expense of one of the others.

Let us suppose we have thirty cells each giving a pressure of one volt; if these cells were connected in *series* the pressure at the terminals would be thirty volts.

The human skin offers quite a high resistance to the passage of electricity, interposing with the ordinary sponge discs from 5,000 to 10,000 ohms, so if the proper electrodes were attached to the two terminals of this battery, which gives a pressure of thirty volts, and these electrodes were held in the hands of a person whose resistance is 6,000 ohms, we could, by Ohm's law, compute the current flowing through the person, as follows:

$$\text{Current (C)} = \frac{\text{30 Volts (E)}}{\text{6,000 Ohms (R)}} = \frac{1}{200}\text{Amp., or 5 milliamp.}$$

Other parts of the body vary as to their resistance to the current owing to the different texture of the skin, while the tissues and underlying fascia are fairly good conductors and offer but little resistance. Again, the larger the electrode the less the resistance, so with a large surface electrode on the abdomen attached to one terminal of the same battery and the other terminal attached to an electrode in contact with a mucous surface in the intrapelvic cavity, the resistance would be much decreased and instead of 6,000 ohms it would be about 300 ohms. Now take the same battery we used for the other experiment, which gives a pressure of thirty volts, and apply the electrodes as above, and, by Ohm's law, we have the following:

$$\text{Current (C)} = \frac{\text{30 Volts (E)}}{\text{300 Ohms (R)}} = \frac{1}{10}\ \text{Amp., or 100 milliamp.}$$

From this we deduce the fact that the resistance or ohms play a very prominent part in every operation by electricity, for it has been shown that a certain battery causes five milliamperes to flow through a certain part of the body while the same battery applied to another part of the same body with different electrodes allows a flow of one hundred milliamperes of current. The question then, "How many milliamperes will my battery give?" means absolutely nothing, for the amount of current we are able to get in any electrical operation depends entirely upon the resistance interposed.

If the resistance of the various parts of the human body were known, and if these were the same in all patients, and if also the voltage of the battery were constant, then the amount of current flowing could always be reckoned by Ohm's law. But unfortunately these are variable factors, for the resistance of the body is constantly changing and the battery, because of polarization and other causes, is never constant, therefore it becomes absolutely necessary to have some means of determining how much current is flowing, for it is *the current that does the work,* the voltage being only the force that pushes it through.

The instrument we call the milliampere meter, which is used for determining the current passing through the patient, should be a part of the armamentarium of every electro-therapeutist, for although we do not always know the exact dosage required, we at least know *how much we are using,* and with any new therapeutic agent this is always desirable for purposes of comparison, and then again the meter is always an index of the condition of the battery.

MILLIAMPERE METER.

Not long ago a physician sent for the author to ascertain, if possible, why he was not getting results from the use of galvanism, when it was proven to him that on account of improper manipulation of his battery he had not been getting any current whatever, although he had been using his battery for a period covering several months. *He had no meter.*

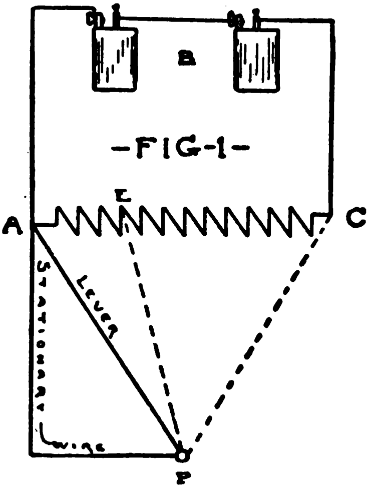
It does not mean anything to say you use five, six or ten cells, neither is it possible to gauge the strength of current by the sensation of the patient, for the electro-sensibility of people is as variable as their resistance; and while one person will complain at a current strength of five milliamperes, another will scarcely feel twenty.

With a good meter in the circuit it does not matter what the resistance of the patient, because we can turn on current until the meter marks the required dosage independent of the fact of whether we have used ten cells or five cells.

Before leaving this subject we feel impelled to say something of the means for *controlling* the current. Usually this is accomplished by a double switch or cell selector which is quite unsatisfactory, especially in case the electro-sensibility of the patient is above normal, as the adding of a single cell to the circuit oftentimes causes an unpleasant sensation, and we are therefore unable to reach the desired dosage.

Resistance fills two important offices in the use of electricity for any purpose. First, it reduces the amperage or rate of flow of current. Second, it produces heat. From the first fact, then, we must conclude that while resistance placed in a circuit reduces the amperage, it does not correspondingly affect the voltage or pressure upon the line. From the second fact we conclude that anything that offers resistance to the flow of a current of electricity produces heat, and the most heat is developed at the point of the greatest resistance. The latter fact is only due to an interchange of energy. In this instance part of the electrical energy is dissipated into heat energy.

A rheostat is an instrument for the purpose of furnishing a variable resistance. In other words, it is an instrument by which the resistance in a circuit may be increased or decreased at the will of the operator. These instruments are usually of two varieties: the series and shunt. Until very recently the former variety was the one in general use, but is now almost obsolete because it simply reduced the flow of current without materially affecting the voltage on the line. The shunt variety, the one being in common use upon all modern batteries today, is really not a current selector in the true sense of the word, but more of a volt selector. In other words, there is only one way we know of for reducing the voltage or pressure in a circuit and that is by shunt.



-FIG-1-

A shunt is simply a loop off the main circuit. The term is not, strictly speaking, an electrical word. Shunt rheostats are of two varieties, as in use at the present time for therapeutical purposes; the graphite and those composed of other resistance metals. As there is considerable difference in the working of these two varieties, it is deemed advisable to give a description of both.

Suppose the operator takes in each hand a conducting wire and places them in contact with a bare wire overhead carrying a current of electricity. As long as the two wires in the hands of the operator touch each other upon the main wire the person receives no electricity because there is no circuit, but if the wire in the left hand is held stationary and the one in the right hand moved over the surface of the wire from left to right, then the person forms a loop and is a shunt off the main circuit, and the farther these two wires are separated, or, in other words, the greater the distance between the two points of contact on the wire, the more current will flow through the person.

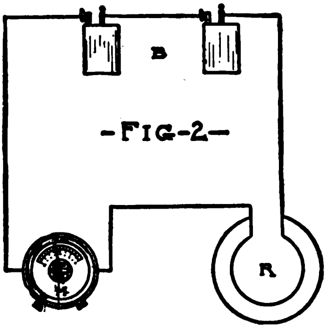
In the diagram shown herewith B is the battery and the wave line A C represents the graphite surface of a rheostat, which, for purposes of illustration, has been straightened out in place of being circular; P is the patient and the line A P the movable lever.

As long as the lever A P remains at the starting point there is no shunt, consequently the patient P receives none of the current flowing through the graphite, but should the lever be moved toward the right to the point E on the graphite surface, then the patient P receives current from the main circuit in proportion as the resistance from A to E varies as the resistance of the loop A P E.

If now the lever be moved still farther to the right until it reaches the point C, then the current the patient receives will be in direct proportion as the resistance of the graphite A C varies as the resistance of the loop A P C.

It will become apparent that if the resistance from A to C is much greater than the loop A P C, then most of the current will pass through this loop in which the patient is placed. If, however, the resistance in the graphite from A to C varies as it does in most graphite rheostats, and if so much graphite has been spread upon the surface of the slate that the resistance from A to C is less than the resistance of the loop A P C, then the latter circuit will receive very little current. The writer's attention was forcibly called to this fact lately by the receipt of a number of letters from parties throughout the country who had purchased batteries, making statements something like the following: "I have fifty cells attached to my wall plate and I am treating the patient for some pelvic trouble, having a large electrode upon the abdomen and a small one upon a mucous surface in the vagina. Now, I have my rheostat turned round as far as it will go and all my meter registers is six or seven milliamperes. What is the matter with my battery? I have written to the manufacturers, who tell me that I have not enough battery power, so I have added more cells, but only increased my amperage in the above mentioned operation by three or four."

These complaints have gotten to be so frequent that the writer concluded to make an investigation, and was surprised to find that many manufacturers who were making a shunt rheostat did not know the principles upon which it was constructed. At one of the factories visited the proprietor was asked if we could see the person making the rheostats. This request was readily granted, and we saw a workman spreading graphite upon a slate surface with a brush, which, being allowed to dry, was afterwards polished much the same as we would do to a stove. When we asked the question whether the workman paid any attention to the amount of graphite placed upon the slate, we were told that he did



-FIG-2-

not, because it made no difference. Then we asked the workman to connect up a rheostat and milliampere meter in series with the 110 volt current as in Fig. 2, in which B is the battery, R is the rheostat, and M the meter. It will be readily understood that the meter M must measure the amount of current flowing through the circuit and the voltage in this circuit being known, we may then easily calculate the resistance on the graphite rheostat R. In the instance in question, the meter, when placed in circuit as herein described, registered 100 milliamperes. If we take Ohm's Law $c = \frac{E}{R}$, we then have from our experiment, as shown in the diagram, where the meter registers 100 milliamperes, or 1-10 of an ampere, the following: $\frac{1}{10} = \frac{110}{R}$; $R = 1100$, from which we ascertain that the resistance of the graphite rheostat from the A to C (see Fig. 1), is 1,100 Ohms. Now the resistance of the patient's body varies from 5,000 to 10,000 Ohms, so that in this instance we would have all or nearly all the current flowing over the lesser resistance from A to C, rather than through the loop A P C, consequently the patient would receive little or no current, and we must conclude there is too much graphite spread upon the slate. If, now, we take a fine piece of emery or sand paper and gently rub off some of the graphite surface on the rheostat R, the resistance in the circuit will be correspondingly increased and the meter will go down. Suppose we rub the graphite off from the rheostat R, until the meter M registers ten milliamperes or 1-100 of an ampere, then we have the formula from Ohm's Law $\frac{1}{100} = \frac{110}{R}$ $R = 11{,}000$, from which we deduce that the resistance of the rheostat R has been altered from 1,100 Ohms to 11,000 Ohms, and consequently the resistance from A to C (Fig. 1) being 11,000, and the resistance of the loop A P C being very much less, more current will pass through the loop than over the main circuit.

The main fault, then, in the graphite shunt rheostat comes from not being able to standardize the resistance. In other words, the resistance of the graphite rheostat is seldom alike in two instances. The operator must be constantly taking off or putting on graphite in order to overcome these difficulties. Another very important objection in the graphite surface has been referred to in the former part of this article, when it was stated that whenever a current of electricity passes through any resistance, heat is evolved. Now the current in passing over the graphite, necessarily heats it and graphite and carbon having the peculiar property of having their resistance *decreased* by heat, the meter will keep going up for some time after the rheostat has ceased to be turned on.

If, now, the resistance material A C were changed from graphite to some high resistance wire in coil, we could establish a *known* resistance in the main circuit at all times, as, for instance, when the contact was at E (Fig. 1) we would have established in the patient's circuit A P E, a definite and known amount of voltage, just as such voltage would be definite if the lever were placed anywhere along the resistance surface A C.

CHAPTER V.

POLARITY AND POLAR EFFECTS.

As has been previously observed, a battery is an apparatus for destroying, by chemical action, the equilibrium of the ether, thereby causing a difference of level, and what we call a *current* of electricity flows from the higher to the lower level. The higher point is called the anode or positive pole, while the lower is called the cathode or negative pole, therefore a current of electricity flows *from* the positive *to* the negative pole.

As has been stated in a previous chapter, the generation of electricity in the galvanic cells commences at the surface of the zinc below the fluid, because the chemical decomposition takes place there, and wherever there is a chemical decomposition there is a generation of electric energy. The zinc, then, is the positive element *within the cell,* because the current flows from that point, and the carbon is the negative element; but above or *outside* of the fluid this order of things is reversed, and instead of speaking of the zinc and carbon as elements, they are called *poles;* the carbon terminal is called the *positive* pole and the zinc terminal the *negative* pole.

These two poles have certain peculiar properties, both physical and therapeutical, in which they are in diametrical opposition, as the following comparative statement will show:

POSITIVE POLE.	NEGATIVE POLE.
1. Oxygen.	1. Hydrogen.
2. Acid.	2. Alkaline.
3. Will stop bleeding.	3. Increases bieeding.
4. Sedative.	4. Produces hypersensitiveness.
5. Hardens tissue.	5. Liquifies and disintegrates.
6. Is an acid caustic and the resultant cicatrix is hard and unyielding.	6. Is an alkaline caustic and the resultant cicatrix is soft and pliable.
7. Is a vaso constrictor.	7. Is a vaso dilator.

It would then seem that in the application of the galvanic current *polarity means everything* and that if the application of the positive pole were indicated the negative would surely do harm. Physicians just beginning the use of electricity will do well to keep these points in view, as success is largely dependent upon which is used for the *active* pole.

As far back as the year 1859 Funke discovered that a sound living nerve is neutral or feebly alkaline, but changed to acid on coagulation setting in, or on exhausting it by prolonged mechanical or electrical stimulation. The death of the muscle is marked by a progressive acidity and subsequent coagulation of the muscular plasma.

The body fluids are largely composed of water, and therefore contain oxygen and hydrogen. In the process of electrolysis the former is electro-negative and collects around the *positive* pole, the latter goes toward the *negative*, and it is this affinity that gives the two poles an exactly opposite therapeutic effect. If the application of one pole is indicated for a certain condition, the other will aggravate it, so it becomes necessary to become thoroughly conversant with this part of the subject.

Oxygen is an *acid maker,* consequently the tissues adjacent to the *positive* pole are rendered *acid.* An acid condition is *against pain,* because it means the beginning of the death of tissue, consequently we call the positive pole *sedative.*

Hydrogen is an *alkali maker,* therefore hydrogen collecting around the negative pole—the tissues in the immediate vicinity of this pole are rendered alkaline. An alkaline condition means a condition of over-stimulation or *irritation.* All inflammations are due to an excessive *alkalinity* of the part. It is evident, then, that while the positive pole will alleviate an inflammatory condition, a negative application will produce a state simulating inflammation.

All inflammations are due, as stated above, to excessive alkalinity of the part, not because the system contains an excess of alkali, but that we have an unequal distribution of probable normal alkalinity.

We almost fear to state how we believe this pathological condition is brought about, lest we be charged with being too ultra in our deductions; but a few years hence a writer may not be considered a "crank" who advocates that it is due to a disturbance of the normal electrical currents traversing the body.

If the nerves carry currents of electricity, they have poles; if they have poles, they have the polar effects given herein.

Look how nicely Nature endeavors to distribute the acidity and alkalinity throughout the human body! Where she intends there should be an *acid* or *underactive* condition in any part, she has there a *positive* nerve ending, but where an *alkaline* or *overactive* condition is required, she has a negative nerve ending.

Is it a violent supposition to say that, by violating the laws of nature we have polarized—reversed the direction—of these nerve currents and thereby caused these acid and alkaline conditions to appear where not intended?

We are glad to quote in this connection from such eminent authority as Dr. J. Mount Bleyer, who says: "Yet all this points to the one conclusion and the one deduction, that animal electricity comes first; that it is the prime factor in all the processes of change, of chemical action, or otherwise, within the living body. That without its stimulus of polarization no chemical action can be called into life, consequently none can go on, and tissue metamorphosis, which is life itself, must cease."

Why is it, then, when we place the positive pole over an inflamed and painful surface that the inflammation and pain subsides? Oxygen is set free at the positive pole. Oxygen is an acid maker and the part in contact with this pole being changed to a condition of acidity, the temporary death of the part has commenced, or is in a state of sedation, evidenced by a circumscribed anæsthesia. But what has become of the alkalinity that existed previous to the application of the positive pole? It certainly has not been neutralized by the acidity of that pole, because that would necessitate an evolution of gas which has not taken place.

Alkalies are electro-positive substances and *have affinity for the negative pole.* Consequently the excess of alkali at the point of inflammation is transferred to the neighborhood of the negative pole, which immediately *assumes a hypersensitive condition,* proving that excessive alkalinity causes inflammation, because the part was perfectly normal before the application of the negative pole.

The positive pole, by its acidity, coagulates the albuminoids of the blood and therefore *hardens* or shrinks tissue.

The negative pole acts much like caustic soda or potassium, softening, disintegrating or liquefying tissue; so it becomes apparent that whenever we desire to produce decomposition of tissue, such as warts, moles, or, in fact, any benign growth, it is necessary to use the negative pole.

The positive pole, by its sedative action on the vaso-motor nerves, lessens the lumen of the blood vessels, thereby decreasing the blood supply to the part.

The negative pole, by stimulating the vaso-motor nerves, dilates the blood vessels.

The so-called anæsthesia produced by a rapidly interrupted induction or faradic current is brought about in a different manner than with galvanism, and is more the result of mechanical than chemical action; the rapid impulses given the muscles by a high frequency induction current brings on a tetanic spasm which soon wears it out, causing it not only to lose its normal animal current, but to assume an *acid* condition, which, in this instance, is not due to polar action as with the positive of a galvanic or direct current, but by bringing on the temporary death of the part by fatigue from excessive and prolonged electrical stimulation.

Muscles exhausted by repeated shocks of induction electricity present very small traces of the muscular current (Du Bois-Reymond), and the injurious effects of violent or repeated electrical discharges on muscular irritability have long been known. Veratrine rapidly renders the muscle rigid, unirritable and *acid* (Schiff). It then appears that after the cessation of irritability and the muscular current a *progressive acidulation* commences.

Physicians oftentimes have brilliant results only because the proper pole was accidentally employed, but there need be no guesswork nor empiricism if the fundamental physics of polarity has been learned; and you will neither try to stop hæmorrhage or allay pain with the *negative* pole.

CHAPTER VI.

ELECTROLYSIS—CATAPHORESIS.

Electrolysis is the separating or breaking up of a substance into its elements by electricity, and certain conditions are necessary before this can take place, viz: The substance or electrolyte must be a fluid or semifluid; it must be a conductor of electricity, and one of its constituent elements must be a metal or salt of a metal. Hydrogen is considered a metal, and water being a composition of oxygen and hydrogen, it may be supposed that anything containing water fulfills all of the above conditions; and such is true, provided the water is in a state of fluidity, but although ice is frozen water, it is not possible to separate it by electricity, because, being a *solid,* it does not meet all the necessary conditions. Fats and oils, although fluids, are not capable of being electrolyzed because they are *nonconductors.*

In studying this subject the main fact to be kept in sight is that where substances are broken up into their elements by electricity we have left certain products of decomposition which Faraday named "ions." These ions take a definite direction toward one or the other poles of the battery, some having a strong affinity for the positive pole, others for the negative. Following the universal law that "likes repel and unlikes attract," these ions appearing at the positive must have been repelled by the negative and are therefore *like* the negative and we call them *electro-negative* substances. Likewise those appearing at the negative side we call *electro-positive.*

Those ions which appear at the anode or positive pole are called *"anions,"* and those which appear at the kathode or negative pole, *"kathions."*

The anions are electro-negative and are repelled by the negative pole, because they are the same potential as that pole. The kathions are electro-positive, and being repelled by the positive pole, whose potential is the same, they are drawn to the negative pole.

The destruction of superfluous hair, warts, moles, nævi, etc., all come under the head of electrolytic work, and the products of decomposition in such work are taken up by the absorbents.

In all cases electrolysis of tissue is accomplished by the use of the negative for the active pole. because it acts as an alkaline caustic and has a disintegrating or liquefying effect, while the positive pole, on account of its acidity, has a tendency to harden, dry and produce coagulation of tissue.

The process of introducing medicines into the body by the aid of electricity is termed "cataphoresis," and as many conflicting statements appear in the literature upon this subject, it is well to consider it in detail from a *physical* standpoint.

Because a constant current goes from the positive pole toward the negative, it is generally supposed that all medicament must be placed upon the positive pole, so as to be *forced,* as it were, into the tissues by the *direction* of the current alone.

Cataphoresis, however, is an electrolytic process, following closely the law of electrolysis, and whenever suitable medicine is placed upon *either* pole of a galvanic battery, that medicine is decomposed or broken up into its elements or ions. These ions, then, having an affinity for one or the other poles of the battery, the selection of the *active* pole would depend upon which *part* of the medicament we wish to use. Suppose, for instance, we have a solution of lithium citrate on one of the poles of an acting galvanic battery, the current in passing through the solution *breaks it up* into lithium and citric acid. The lithium or base has a strong affinity for and moves *toward* the negative pole, while the citric acid has just as strong an affinity for the positive. It becomes evident at once to the most casual observer that if it is desired to utilize the lithium as the medicament it must be placed upon the positive pole because it is *repelled* by that pole, and, in seeking its affinity, the negative—which is on some other part of the body—it is carried deeply into the tissues, the depth depending upon the amperage employed and the length of time it is allowed to flow. If, however, the solution be placed on the positive electrode for the purpose of utilizing the lithium or base, as described above, the citric acid, having no affinity for the negative, will remain at or upon the positive electrode and not penetrate the tissues.

Iodin, bromin, chlorin and oxygen are anions or electro-negative elements and have a strong affinity for the positive pole; therefore, when treating, for instance, an enlarged thyroid gland with solution of potassium iodide, we must use the solution on the *negative* pole if we wish to utilize the resolvent effects of the iodin.

Nearly all of the metals, so far as we know, are kathions and appear at the negative pole; if, then, we put a solution of potassium iodide on the positive pole and complete the circuit through some conducting medium, the potassium hydrate, being a metal and a kathion, will be transferred through the medium to the negative pole, while the iodin, being an anion, will remain at the positive pole, *for which it has an affinity,* and we would not even have a local application of the iodin, because *all of it* would be left on the electrode.

In treating this class of cases, especially where the enlarged gland is hard and it is desirable to gain time, the writer often uses, hypodermically, dilute Lugol's solution, which is diffused by leaving the hypodermic needle in place and using it as the negative electrode. For this purpose it is only necessary to take an all metal hypodermic syringe and solder on it a receptacle for the cord tip. Such an electrode is also valuable for the painless removal of growths by first injecting into them a drop or so of solution of cocaine, and, without removing the needle, which is attached to the negative pole, turn on sufficient current to decompose the growth without causing the patient any appreciable pain.

Binary compounds are composed of a base and an acid or that which takes the place of an acid. The acid or that which takes its place (the iodin in potassium iodide takes the place of an acid) is an electro-negative element or anion, all the bases are electro-positive or kathions, and if we were using a solution of morphia sulph. or cocaine hydrochlor., we would apply from the *positive* pole, when the base, which in this instance we wish to utilize, will be transferred through the tissues to the negative pole, *for which it has an affinity.* When using a solution of potassium iodide it is not for the purpose of the operation to convey the potassium or base through the underlying tissue but the iodin.

We can produce the most profound local anesthesia through the skin by using a solution of cocaine cataphorically and do minor surgical work, such as the removal of small growths or the incision of an abscess without pain to the patient, but the cocaine solution must be placed upon the positive pole.

If it were kept in mind that all *bases,* whether metallic or alkaloidal, have an affinity for the *negative* and are repelled by the positive, and that the *acid*, or that which takes its place, has just as strong affinity for the *positive* and is repelled by the negative, then the rule would be stated as follows: If we wish to utilize the base the medicament should be placed on the *positive* pole, but if it is the acid that is desired we must use it from the *negative* pole.

CHAPTER VII.

METALLIC CATAPHORESIS.

The current name for this process, "Metallic Electrolysis," is so misleading that the author has taken the liberty of substituting what he thinks a better one, and, at the same time, making some corrections in the physics of the process.

The name "Metallic Electrolysis" is evidently not descriptive of the process, because we cannot produce electrolysis of metals, and, as it consists in the introduction of metals into the tissues, *metallic cataphoresis* seems more appropriate.

That it is electrolytic in character there can be no question, because all cataphoric processes follow the law of electrolysis.

Oxygen is evolved at the positive pole, and if an electrode composed of one of the baser metals, copper, zinc, etc., be used on that pole the oxygen combines with it, forming an oxide of the metal on its surface. Text books upon this subject tell us that this oxide of the metal combines with the body fluids to form an *oxychloride,* and is taken into the tissues in the form of this double salt.

This is evidently erroneous, because oxygen and chlorine are both electro-negative, and, having a strong affinity for the positive pole, never leave that electrode. If an oxychloride of the metal does form in the immediate vicinity of the positive electrode it is again broken up by electrolytic action, the oxygen and chlorine remaining at the anode, while the *metal only* travels toward the cathode. What does take place, then, is that the *metal* is taken into the tissues in a very *minutely subdivided condition* where it really does combine with the body fluids to form a chloride, but as electrolysis takes place all along the path of the current the chlorine is kept moving toward the anode and the metal in the direction of the cathode. When the current ceases to flow a chloride of the metal of which the positive terminal was composed is left in the tissues, its depth depending on the strength of the current and the length of time it was allowed to flow. If the process be continued for sufficient time the *pure metal* would be deposited on the cathode.

The value of the application is based upon the *minute subdivison* of the metal and the readiness with which, in this condition, it will combine chemically with the body fluids, which contain sufficient sodium chloride to form a chloride of the metal.

So far as we are now aware copper is the most valuable metal for purposes of metallic cataphoresis, because its salts are more antiseptic than those of other metals. In fact, the salt formed by this metal and which is taken into the tissues from the positive pole of a galvanic current has eight times more microbicidal power than the positive pole alone, which of itself is germicidal. (See Chapter XIX.)

The range of the application, therapeutically considered, will become apparent to the reader when the statement is made that it is indicated in all pathological conditions dependent upon germ origin, and, therefore, many conditions not considered amenable to electrical treatment by ordinary methods come within its scope.

The tissues directly surrounding the electrode assuming the green color characteristic of the copper salts has suggested the question of toxic effects by absorbtion. The fact that these effects have never been in evidence has always seemed inconsistent with the physical appearance, but the following experiment made by the author will throw some light on the subject.

A copper wire was accurately weighed on an analytical balance, after which it was attached to the positive pole of a galvanic battery and introduced into a piece of fresh beef. Sufficient current was used for ten minutes to deeply color the tissue. The electrode was weighed again, when it was found there *was not a toxic dose* of the copper dissolved.

The positive pole is a great dehydrater of tissue, and when a bare metal electrode is used on mucous or subcutaneous surfaces the moisture is taken from them so rapidly that the metal will stick, causing the operator much inconvenience by traumatism, bleeding, etc. This may be avoided in most instances by covering the electrode with absorbent cotton or chamois leather, and the metal will be deposited in the tissues *through* such covering, but where it is impracticable to do this, as in the uterus and similar cavities, the electrode must be gently rotated while the current is flowing. The practice of reversing the current to free the electrode is not to be commended, because much of the copper that has been deposited in the tissues is redeposited back on the electrode when it is made the negative pole. When it is not practicable to cover the electrode the best method is to gently rotate it until we find it getting dry; then turn off the current before the sticking point is reached.

In such cases as trachoma, lupus, indolent ulcers, endometritis, fistulous tracts and many other germ troubles its action is not excelled by any other remedy. The application has its advantages and disadvantages, and among the former may be mentioned the fact that inasmuch as the *polar* effect of the current is *expended upon the metal* composing the electrodes it is not so apt to cauterize the tissue in contact with the electrode, and consequently rarely leaves that undesirable hard cicatrix which characterizes an application ot the positive pole to a mucous surface. The principal disadvantage is the sticking of the electrode, as has been mentioned above.

The chloride of zinc being a powerful escharotic, the use of that metal is almost limited to the application to the stump after excision of malignant growths, recurrent cancers, etc., although in many uterine lesions Dr. G. Betton Massey strongly recommends the application of a zinc and mercury amalgam by means of the positive pole.

When using an iron or steel electrode on the positive pole we get all the styptic and tonic effects of the iron locally applied. We have an ocular demonstration of this when the wrong pole happens to be used in removing a hair, viz., leaving a black tattoo mark of the oxide of iron under the epidermis, which is not easily removed.

CHAPTER VIII.

FARADISM—MAGNETISM.

The electrical fakir largely prefers the field of faradism, because that current manifests itself by a buzzing noise, more or less intense, and gives a current of considerable sensation, both of which tend to impress the patient.

The physics of the faradic or induced current are somewhat more complex than the galvanic or direct current, and ever since the first induction apparatus was made by Faraday, in England, and Henry, in America, so many changes have been made and so many forms suggested by the various manufacturers that the average physician is totally at sea relative to the best faradic apparatus for therapeutic purposes.

We will here consider briefly enough of the rudimentary physics of faradism so that the various fads and conflicting statements instituted by manufacturers may not be the means of depleting the purse of the credulous and too trusting physician.

We have three kinds of magnets, viz., the lodestone or *natural* magnet, the piece of hardened steel, which, when once magnetized, retains its magnetism and is called the *permanent* magnet, and the *electro*-magnet, which is usually a very soft iron core surrounded by a coil of insulated wire in which magnetism is induced by a flow of electricity through the coil of wire. The value of the electro-magnet depends upon the fact of its being enabled to rapidly acquire its magnetism on the passage of the magnetizing current and as readily to lose it on the cessation of such current.

For purposes of illustration please imagine that a certain bar of soft iron is closely packed with an innumerable, indefinite number of small, endless chains, which, when a current of electricity is passed around the bar, are thrown out as in Fig. 6, but are immediately withdrawn again when the current around the bar is stopped. These imaginary chains we call the *magnetic lines of force,* and they are supposed to know no barrier and travel in closed paths from N (north pole) to S (south poie), much the same as a current of electricity goes *from* the positive *to* the negative pole.

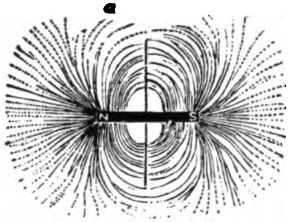


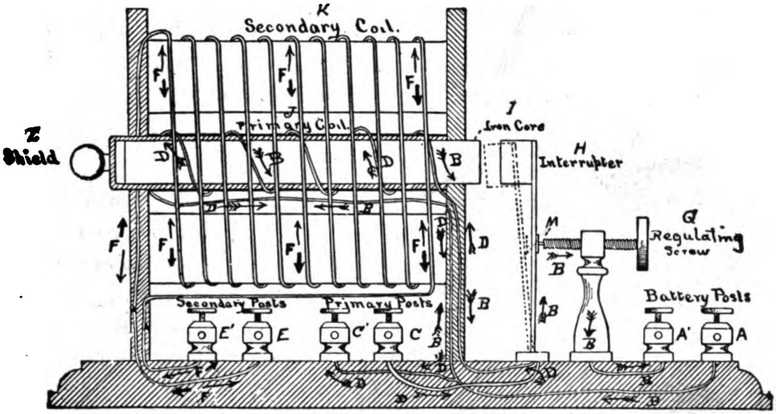
FIG 6.

A simple experiment will serve to show what we mean by an induced current: If I take two ends of a noncurrent bearing wire in my hands and suddenly move this loop into a magnetic field—i. e., a field permeated by magnetic lines of force—an electro-motive force is generated in the wire *at the time of the transfer only;* but when we remove the loop from the magnetic field another E. M. F. is induced in the wire during the transfer but flowing *in an opposite direction* from the first. The quicker we make the transfer of the loop in and out of the magnetic field, the higher the E. M. F. induced in the wire. In a nutshell these are the prime principles of every faradic battery, except that in the latter the magnetic field is the movable factor, while the wire remains stationary.

No change can be detected in the wire so long as it remains at rest relative to these lines of force, but if motion takes place so that the wire is linked with more or less of the lines, then an E. M. F. is generated along the wire during the change.

We will now apply these principles to the faradic or induction coil, and in order to make the matter plainer we will show (Fig. 7) a diagram of an induction apparatus.

As will be seen by this diagram, the essential parts of every faradic coil are, viz.: (1) A primary coil directly surrounding a (2) soft iron core; a secondary coil surrounding the primary, but entirely insulated from it; an automatic hammer for interrupting the current from the battery cells.



Working Diagram. Physicians Induction Coil

FIG 7.

Fig. 8 would represent the soft iron core and primary coil of a faradic battery; this core is not a magnet until a current of electricity flows through the wire which surrounds it, when it becomes strongly magnetized and throws out lines of magnetic force, as in Fig. 6, which, in their effort to travel in a circuit from the north to the south pole of the magnet thread through the convolutions of wire composing the coil and induce a current of electricity to flow in one direction during the influx of the magnetic lines and in the opposite direction at the time of their withdrawal, just as the current was generated in the loop of wire when held in the hands by being moved into and taken out of a magnetic field, except in this instance the magnetic lines go into the convolutions of wire instead of the wire being moved into the magnetic field.

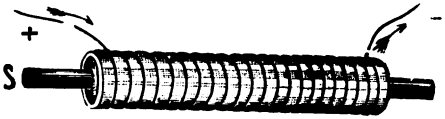


FIG. 8.

This alternate influx and withdrawal of the magnetic lines can be easily understood by referring to Fig. 9. The slender spring fastened in the slot at R *just touches* the point of the thumbscrew T at X, and it is at this point that the circuit in the primary wire is "made" and "broken." When the current flashes through the primary—i. e., the coils of the wire directly surrounding the iron core—the latter is magnetized and throws out lines of force, as in Fig. 6, which permeate the convolutions of both the primary and secondary coils; at the next instant, however, by magnetic action the hammer H is drawn toward M, which breaks the contact at X, and as the current ceases to flow through the primary coil the core loses its magnetism and the lines of force are withdrawn from the convolutions of wire, thus generating the inverse current above referred to.

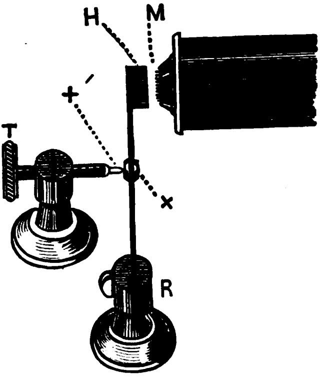


FIG. 9.

The greater number of turns of wire in the coil—or, in other words, the more times we can cut the magnetic lines—the greater the E. M. F. generated, but the quantity or current will be correspondingly lessened on account of the increased resistance of the wire.

From a careful study of the foregoing principles it will be apparent that the induced current we use in every faradic apparatus is obtained by the agency of magnetism, and the principal office of the primary or inner coil directly surrounding the soft iron core is to convey the current from the battery cell around the core, thus magnetizing it. One or two galvanic cells are sufficient to operate a faradic coil, and, although it would be impossible to detect a current from these cells by the sensation, yet when we take hold of the terminals of the primary coil that is operated by these same cells the sensation is considerable. This increased E. M. F. is caused by the magnetic lines of force permeating the convolutions of wire, consequently it is not the current from the battery cells that we feel but the current *induced* in the convolutions of wire by the influx and withdrawal of the magnetic lines.

The same is true of the secondary coil, which is insulated from and has no connection with the primary, and, therefore, could not be influenced by the current from the battery cells, except that the more cells we add to any faradic apparatus the greater magnetic saturation of the core, and, consequently, the higher electro-motive force induced in both primary and secondary coils.

Of the many fads in vogue pertaining to induction coils the "high tension" fad is the most popular at the present time and, at the same time, the most expensive for the trusting physician whose knowledge of electro-physics is limited. He is told to use the "long, fine wire secondary," rapidly interrupted, for purposes of sedation, and is further informed that he cannot do good work unless the secondary coil has so many thousand feet of fine wire. What are the facts?

Ten turns of wire as thick as a finger will give exactly the same voltage in an induction coil as ten turns of wire as fine as a hair, and we can produce just as good sedation with a *coarse* as with a *fine* wire coil, because the therapeutic value of this current depends more on the *character of the interruptions* than in the length or thickness of the wire in the coil.

The so-called local anæsthesia produced by rapidly alternating high tension currents is simply done by tetanizing and fatiguing the muscle or nerve, and the writer does not believe it is as good or permanent as the relief of similar cases brought about by the action of the positive pole of the galvanic battery.

The physician is told again that he must use a coarse wire secondary, *slowly* interrupted, for purposes of massage, because the coarse wire gives a "current of quantity" and it takes *quantity* (meaning amperage) to produce muscular contractions.

Let us see if this statement is based upon good physics. If we have a coarse wire coil we have a fewer number of turns, and the latter means a lower voltage. If the voltage is low the patient receives *less* current, irrespective of the fact that a coarse wire will carry more current than a fine wire.

The primary coil will answer therapeutically for a coarse wire secondary, and, having a fewer number of turns, the voltage will be correspondingly decreased; therefore the term "current of quantity," generally used in connection with coarse wire coils, only means, therapeutically speaking, that the *patient receives less current* because the voltage is lower.

The secondary coil being wound with finer wire, we have cut the lines of force thrown out by the magnet many more times than with the coarser primary wire, and, therefore, have a higher induced E. M. F., and our patient receives more sensation than from the primary; but the greater length of wire in the secondary offering a greater resistance to the passage of the current we get less current, and by adding sufficient wire may obtain a current simulating the "static," in which the voltage is very high and the quantity so small as to be almost inappreciable.

The faradic current is a general tonic in its nature, assisting metabolic action and eliminating waste products, but is more mechanical than medicinal. Its greater value is in the slower interruptions, and the improvement in faradic coils will not be in putting a great length of wire in the secondary coil.

Let your faradic battery have a good primary coil with sufficient wire to thoroughly magnetize the core, and a secondary coil of finer wire, probably about 1,000 yards in length, and an interrupter giving from forty to fifty up to 50,000 interruptions per minute, and trust its manufacture to some reliable firm and you will not be disappointed in the results obtained from the apparatus.

While the author is fully aware that the foregoing matter pertaining to induced currents does not coincide with the views expressed by most writers and manufacturers who must have some "talking point" for their instruments, it is nevertheless based upon sound physical principles.

CHAPTER IX.

THE PHYSICS AND PRACTICAL OPERATION OF THE STATIC MACHINE.

This treatment of the static machine must necessarily be limited to statements of principles and facts without full proof of all the points that are claimed. There is, however, one principle which seems to be entirely neglected by those who have attempted to explain the operation of the static machine, viz.: The fundamental methods by which a body may become charged. All the therapeutic books on the subject assume that a body may become positively charged, for instance, by friction, by direct contact with a positively charged body or by induction. By this last term is meant that a positively charged field piece on the stationary plate will, by induction, produce a positive charge on the prime conductor directly in front of it. It is the writer's belief, based on a number of experiments, that there is one more fundamental method of giving a positive charge to a conductor, viz., by taking a negative charge from it. This principle is made use of in the static machine in charging the prime conductors, and we will have occasion to allude to it more in detail in the body of this chapter. There is one more point which must be emphasized and which is lost sight of by many: that if a positive charge is first given the body and later an equal negative charge, the body will be neutral, and thus conversely a neutral conductor may be regarded as equally charged with positive and negative electricity. A long spark has its red end on the positive terminal and its white end on the negative terminal. A positive point gives a spray when seen in the dark, while on the negative point appears a star. It is thus possible to easily determine the kind of a charge on any part of the static machine when looking at it in the dark.

TYPES OF STATIC MACHINES.

In this country there are in use three types of static machines: The Toepler-Holtz, the Holtz and the compound machines. Abroad the Wimshurst is frequently used, but as it is not in use in this country it will not be described. The parts common to all the three types named above are the following: Stationary plates, on each of which are pasted two paper sectors or field pieces; revolving plates; prime conductors; neutralizing rod or equalizer, and leyden jars. The parts distinctive of the Toepler-Holtz machine: Metal discs on all the revolving plates, brushes attached by metal arms to the paper field pieces and brushes on the equalizer. Parts distinctive of the Holtz type: No disc on the revolving plates; no brushes; a small Toepler-Holtz or Wimshurst to excite the machine; each stationary plate divided into an upper and lower section by a horizontal air gap, and each paper sector provided with a set of metal points. Parts distinctive of the compound machine: Metal discs on one or more rotary plates; no gap in the stationary plates; paper sectors provided with points which are pasted on the external surfaces of the stationary plates next to the revolving plates.

The distinctive features in the operation of each type of machine is the method by which the paper sectors or field pieces are kept charged. In the Toepler-Holtz machine the primary charges are produced by the friction of the metal discs against the brushes connected with the field pieces. As a result of this friction one field piece becomes positive and the other negative.

Let us now describe the actual operation as would be seen in a machine and refer to Fig. 1. While the right sector is

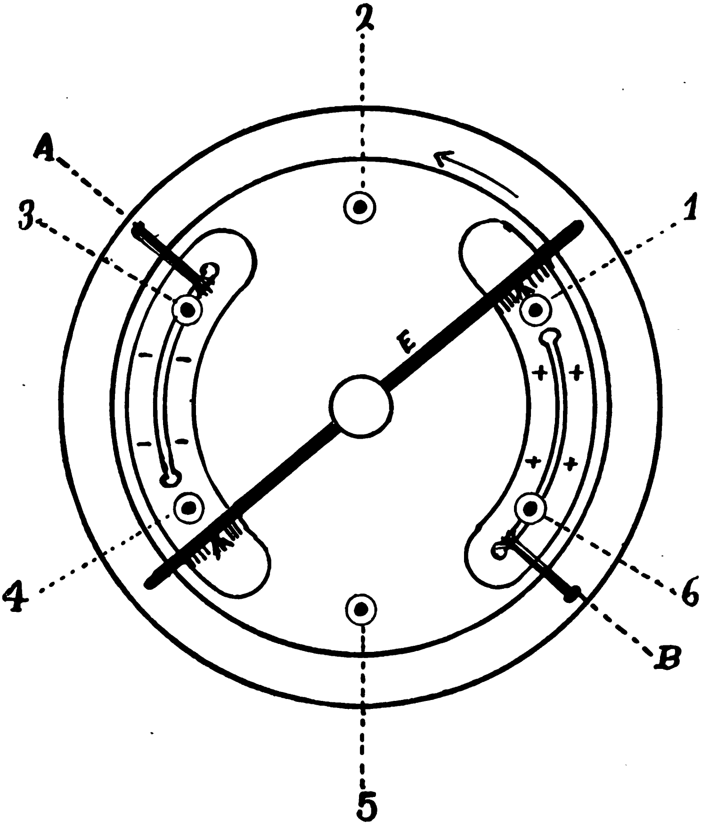


FIG. 1.

positive and the left sector negative, the equalizer "E" is shown in its position and a button, No. 1, is just ready to touch the brush of this rod, which is in front of the + sector. This button, as all conductors, has both positive and negative charges when in the neutral condition. It is in front of a + sector, separated from it by two glass plates and a small air space. The repelling force of the + charge can, however, be exercised on these non-conducting materials and will repel from button No. 1 a + charge. By the rotation of plate it will be brought into position No. 2, where it will then have a free — charge. This is a case of induction. This button will next revolve in position No. 3, where it has touched brush "A" and given its charge to the — paper sector. By the operation of the machine charges are constantly being added to this paper sector and it will thus soon become powerfully charged. Button No. 3 will be left practically neutral, having had its free negative charge removed; it will revolve into position No. 4, where it will be in front of a — paper sector and will touch the lower brush of "E." Here a — charge will be drawn from it and it will then be left positive, when it revolves into position No. 5; in position No. 6 it will give up its + charge to the + paper sector through brush "B," and other buttons will follow suit. It is thus evident that the right and left paper sectors will soon become very powerfully charged.

METHOD OF CHARGING THE SECTORS OF THE HOLTZ MACHINE.

Since this machine has no buttons the charge of its sectors must be by a very different principle. We found that in the Toepler-Holtz type charges are carried to the paper sectors by the buttons. In this type negative charges are withdrawn from the positive sector through its metallic points upon the internal surfaces of the rotating glass plates.

These surfaces are not utilized in the Toepler-Holtz type, except for purposes of induction, and it is, therefore, evident that the Holtz type has a larger effective area than the Toepler-Holtz, all other conditions being equal.

METHOD OF CHARGING THE COMPOUND MACHINE.

Since this machine has buttons it is self-charging, and since its paper sectors are provided with points the positive paper sectors are *kept* charged by having negative charges withdrawn from them, as in the Holtz type. This type, therefore, uses the internal surfaces of the rotating glass plates.

The prime conductors are charged in the same manner in all static machines but not by having charges collected from either the buttons or the rotating glass plates, as is assumed by many electro-therapeutists. In order to explain this operation fully we must consider the use of the equalizer "E" in all types of machines. This equalizer is supplied with

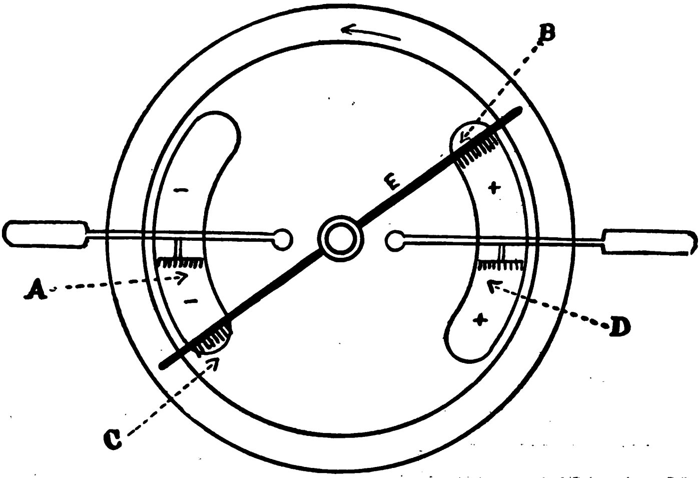


FIG. 2.

a number of points which are always placed in front of the end of the paper sectors and face the rotating glass plates. In Fig. 2 the + sectors draw from these points — charges which, in the dark, can be seen to leak upon the glass plates. This revolves from position "B" to position "A," where it is in front of the horizontal combs of the left prime conductor. This was originally neutral, but since these combs are in front of the negative sector and the negative part of the plates at "A," + charges will be drawn from these combs and will leave the prime conductor —. Just the reverse action takes place in the charging of the right prime conductor, for its horizontal combs will be in front of a + sector and a + plate. The anterior surface of this plate has been charged by having the + charge drawn upon the plate in the position "C" by the negative paper sector, and this moves later to position "D."

DIFFICULTIES IN OPERATING A MACHINE.

The statement is not infrequently met that the static machine is unreliable; that it is apt to lose its charge at the most inopportune times, especially on rainy days, when it is almost impossible to get it to work. From our own experience and the reports of many operators who have taken courses at the Illinois School of Electro-Therapeutics we are led to believe that a machine never fails without having given ample notice. These signs, however, are often disregarded because their significance is not understood.

SIGNS OF IMPENDING COLLAPSE.

1. Frequent change of polarity. This means that, although for months the operator might notice that one pole of his machine is positive, he now sees that the machine begins to reverse polarity every week or so. Gradually these

reversals take place more frequently, until they occur every hour, every five minutes, and possibly even when the machine is being used. The symptoms are in a very acute stage.

2. The machine may not pick up its charge for several minutes after the plates have been set in motion.

3. It may suddenly drop its charge for a minute or two and then pick it up again.

These three symptoms point to one of three causes, viz.: Moisture within the case, dirt on the plates, or degenerated shellac.

Various plans have been devised for getting rid of the moisture. One aiming to make the air dry by heating it. Another by absorbing the moisture through the use of hygroscopic substances. Some operators have incandescent lights within the case, by which the air is heated and thus dried. This has worked very well in the hands of some people, but it should not be widely adopted, because the moisture is not actually removed from the air and the filaments of the lamps are soon fractured by the vibration.

Among the hygroscopic substances there is a wide choice, but unquestionably calcium chloride is the best. Some operators have reported that their calcium chloride gives off free chlorine, which, being an active gas, chemically corrodes the metal parts within the case, and also causes a degeneration of the shellac. Chemically pure calcium chloride will not do this, and in ordering it the chemical formula $Ca\ Cl_2$ should be specified, and this should not be allowed to stay within the case until it becomes watery or even mushy, because a gummy substance will gather upon the plates and the brass parts.

Snow recommends unslacked lime or calcium oxide, putting this substance in a large box, and preventing any fine particles of the quicklime from flying about in the case by covering his box with several layers of muslin. He argues for this that the electrical discharges within the case produce compounds of nitrogen and oxygen, of which there are five different combinations, each of which is acid in character. The quicklime is alkaline and would tend to neutralize any acids. Dr. Gordon G. Burdick was the first to call our attention to another alkaline hygroscopic substance, which is more rapid in action than quicklime—either caustic soda or caustic potash. Like calcium chloride, they can be used repeatedly, driving off the moisture by putting them in the oven and baking. Experience of the manufacturers certainly seems to indicate that there is an acid deposit upon the plates, because in cleaning they invariably use ammonia water. Calcium oxide can also be used repeatedly, but its cheapness would preclude the trouble of drying it.

In case the machine fails to generate in damp weather (a condition which should never be allowed to occur when the operator understands how to take care of his machine) several fruit jars filled with a mixture of cracked ice and common salt can be placed in the case. This being a freezing mixture, much of the moisture in the case will be precipitated upon the sides of the jars, thus leaving the air dryer. In order to put the jars within the case one of the end doors must be removed momentarily and the damp air of the room may find entrance into the case. The end door, therefore, should be put on as quickly as possible.

HOW TO REMOVE DIRT FROM THE PLATES.

Often the use of a clean, dry cloth will suffice to remove whatever little dust may have gathered upon the plates, and this can be inserted between the two approximating movable plates upon a lath or other long stick. In case the plates are dirty they must be washed with kerosene oil or gasoline. In machines where the stationary plates can be removed readily without taking off all the plates from the shaft, this operation is much easier, because the stationary plates can be removed, and then there will be ample room to clean off both sides of each rotating plate. Machines frequently run for years without needing this cleaning process.

HOW TO RE-SHELLAC THE PLATES.

Frequently the only shellac that needs renewing is that on the external surfaces of the rotating plates, and no better proof is required than this—that after such treatment the machine will run for many months with all its early energy. The end doors of the case are removed; some white shellac is dissolved in alcohol to a syrup consistency, not too thick to spread well; a cloth is bound on to a lath to serve as a brush; this is dipped into the shellac and is then applied over the surface of the rotating plates, while these are made to revolve by pulling the belt with the other hand. Shellac seems to give some trouble if applied on a wet day, because it will not dry properly. If this operation is done on a dry day and an abundance of calcium chloride be put within the case after the operation is completed, the machine ought to pick up its charge the next day. If the shellac has been spread over the buttons on the rotating plates it can be cleaned off with a little alcohol, although it is not necessary.

GROUNDING THE MACHINE.

One of the simplest ways of providing ground connection is to string an uncovered wire between the two front legs of the machine beneath the case and running a wire from a water pipe, gas pipe, radiator or furnace register to this wire. The horizontal wire beneath the case will serve as a convenient connection for grounding the machine or any electrode. Frequently it has been stated that if a machine and an electrode are to be grounded the two must be connected by two different wires to the ground. This is absolutely unnecessary. Chains can be attached to this long enough to reach to an electrode, either pole of the machine or to the head breeze electrode. To accomplish this three wires of different lengths could be permanently attached to this horizontal grounding wire.

Should the machine always be grounded? Operators differ upon this point. Some ground the machine in all conditions except when energizing an X-Ray tube; others do not ground the machine at all. The advantage of grounding one electrode is that it becomes the same potential as the operator, who can now touch that side of the machine without getting a spark, whereas if it is not grounded he would get a spark from either pole of the machine. In one respect at any rate the advantage is very great, viz.: in giving spark treatments. Here the operator can hold the grounding chain close to his body in his left hand without getting a spark and his whole attention can be concentrated upon the giving of the treatment. His right arm is free to make rapid swings of the ball electrode over the regions treated. Care must be exercised to prevent the passage of more than one spark to a small area.

CHAPTER X.

FRANKLINIC ELECTRICITY—STATIC CHARGE.

It is only considered advisable to give the reader a few of the principal physical and therapeutic properties of static electricity, believing that any attempt at elaboration might cause confusion, and realizing that correct methods are only gained by experience.

No two operators exactly agree as to the technique to be employed, although the results obtained may be the same; therefore it must be left largely to the operator, who will discover something new and interesting each time the machine is used.

This manifestation of electrical energy properly belongs to that class called "high potential, high frequency currents," in which the voltage is enormous, while the amperage is infinitesimally small, and when we come to consider the fact that it requires about 50,000 volts pressure to force a spark across one inch of air space the tremendous potential energy of static machines becomes apparent, for they are often capable of giving a ten or twelve inch spark.

It is evident, therefore, that the therapeutical effects obtained are not due to electrolytic conduction, because there is little to conduct (competent observers asserting that the amperage generated by the ordinary machines is about .005 milliampere), these effects being mainly due to its oscillatory or vibratory character.

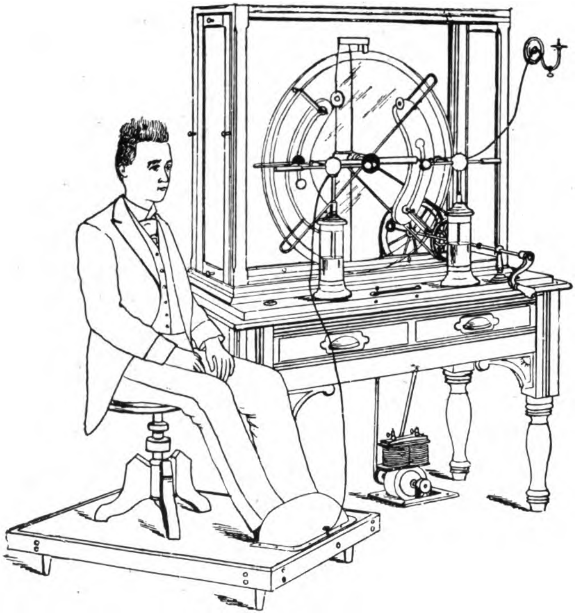
Every time a spark passes between the prime conductors of a static machine oscillations are set up, sometimes many millions per second, and these vibrations, when the patient is included in the circuit, are conveyed to the nerves.

In a former chapter we noted the fact that in health the nerves are all in a state of vibration, and when they lose their vibratory action their function is destroyed and degenerative changes commence. A very simple illustration will serve to show how static electricity does its work and why it is especially adapted for the treatment of disturbances of the nervous system.

We will take five tuning forks—A, B, C, D and E—and place them in an upright position on a sounding board; if now we take an extra C tuning fork and, after causing it to vibrate, bring it in contact with the sounding board, the other C fork will vibrate in unison with it, but none of the others are affected, because the rate of vibration necessary to produce the tone of C is different from that which produces A or B. The nerves in normal condition vibrate differently, and each one will respond only to the vibration that suits it; so, when the function of a nerve is destroyed, it becomes necessary to bring it within the range or subject it to a rate of vibration equal to its own.

In static electricity we have a wide range of vibration, from a few up to many millions per second, and as long as the patient comes within this area of oscillation each nerve is taking the vibration which suits it, which would account, in a measure, for the almost magical results we sometimes have in certain forms of neuralgia, migraine, etc.

Accurate localization is essential for success with any treatment. Althaus cites several cases which have been under his care at various times in which no progress was perceptible, when he applied the electricity to a certain area of the brain which he believed to be affected; but when, on further consideration of the symptoms, a different district of the organ appeared to be at fault and he altered the localization of the current a successful result was obtained. Such occurrences, he says, not only give strong support to the theory that an unsatisfactory condition of brain currents may be improved by artificial electricity applied to the diseased area but it likewise affords a proof that the influence of suggestion, for which now everything and anything is claimed in therapeutics, does not enter to any extent as a factor into electro-therapeutics, because, if suggestion were the active agent, it is much more likely that it would do its work in the beginning of the treatment than after the latter



(FIG. 10.)

had been for some time ineffectual, whereby any suggestive force inherent to the proceeding must have been lessened rather than increased.

The most popular treatment with this form of electricity is what is called *static insulation.*

Fig. 10 shows *positive* insulation. The patient, seated on an insulated platform, is connected with the positive jar of the machine, while the other jar is "grounded" or brought to zero potential by being connected to the earth through a gas or water fixture.

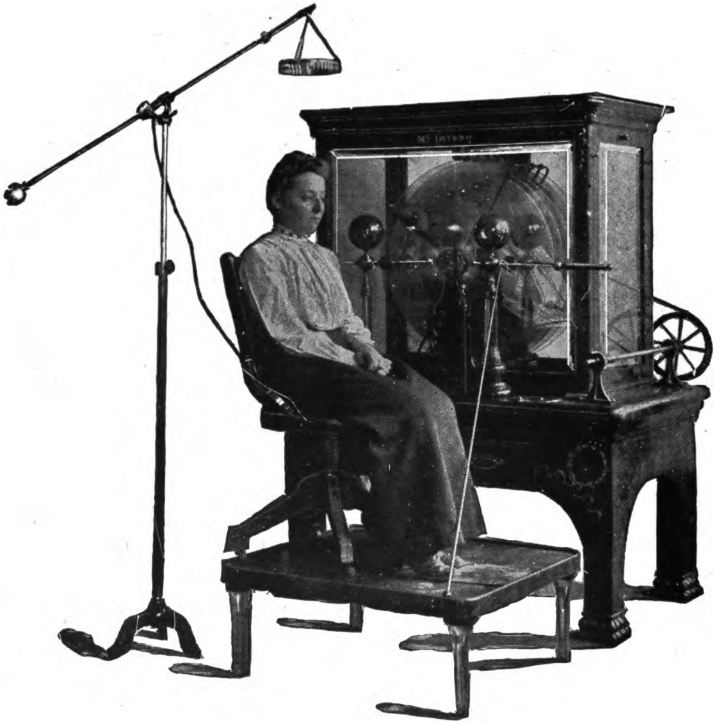
In this operation the potential of the patient is raised to that of the machine, which is very high, and as long as the treatment is continued all the nerves, as it were, are on a vibratory strain.

Another very popular treatment with static electricity is the *static bath* or *breeze* (Fig. 11), which is given by placing the patient on an insulated platform connected with one of the jars on the machine, while the other jar has connection with an inverted crown electrode suspended about one to three feet above the head.

The sensation produced by this treatment is quite pleasant to most patients, the feeling being as a gentle breeze on the head. Its action is that of a sedative and it is especially indicated in cases of migraine, insomnia, etc.

The so-called static induced current which has been elaborated and brought to the attention of the profession by Dr. William J. Morton, of New York, is the current from the outside coating of the jars. It is taken from the binding posts in the base of the machine by means of a switch, and in sensation closely resembles the current from a faradic coil, although it widely differs from that current in both physical and therapeutical properties, being capable of producing a muscular contraction after both faradic and galvanic irritability has ceased.

In conclusion and briefly, static electricity is an equalizer of the nervous forces, hastens the elimination of waste products, such as urea, carbon dioxide, etc., and causes a dilatation of the cutaneous vessels.



(FIG. 11.)

For the better guidance of the reader in the application of static electricity we insert here a working schedule for the arrangement of machine and patient, with indications for use.

PRACTICAL HINTS AS TO ADMINISTRATION OF STATIC CURRENTS.

NAME OF CURRENT	ARRANGEMENT OF MACHINE AND PATIENT	INDICATIONS FOR USE
Negative Head Breeze	Jars removed, prime conductors drawn out beyond sparking distance. Patient connected to the *positive* side of machine. Negative connected to crown electrode placed from one to three feet above head of patient. Time of sitting, 15 to 30 minutes.	**Neurasthenia, insomnia and general nervous conditions. First half of treatment for Chronic Bright's Disease.**
Positive Breeze	Same as above, except polarity is reversed.	**Migraine; cerebral hyperemia etc.**
"Static Surgings" **Morton Wave Current** **Alternating Potential (Monell)**	Jars on or off. Ball or sponge disc electrode attached to top of one jar. The other jar is "grounded." The electrode is now held against the *bare skin* of the patient at any desired point and the prime conductors are gradually separated until the limit of tolerance of the patient is reached. The range of spark gap is usually from ½ to 4 inches. The speed of the machine should be so governed as to give about 3 or 4 sparks per second. A strip of metal on the spine, or other forms of electrode may be attached to the body at any point. Time of sitting, 10 minutes.	**Specific in Neuritis,** **Deep and Painless Massage.**
Positive Insulation	Jars removed. Prime conductors beyond sparking distance. Patient attached to positive side of machine. Negative to ground. Time of sitting, 15 to 30 minutes. NOTE.—In giving this treatment be careful not to come too close to the patient, as a very unpleasant shock may be given.	**Stimulant to Nervous centers. Nervous Prostration etc. Last half of treatment in Chronic Bright's Disease.**
Negative Insulation	Same as above, but with reverse polarity.	**Depressant.**

Static Induced Current	Jars on. Switch pointer on "spray" or "induced." The conducting cords or chains are attached to the posts on *base* of machine; one is attached to the patient by means of a foot plate or otherwise, the other to a suitable electrode in the hands of the operator. The machine is started with the prime conductors *actually touching* each other, and after the machine is generating, they are carefully separated until a current strong enough is obtained (about 1-16 to ¼ inch). NOTE. This current is always better applied to the *bare* skin.	Highly sedative Rheumatism Massage. For all purposes where faradism would be indicated.
Single Spray	Jars removed. Prime conductors beyond sparking distance. Patient is attached to positive or negative side of machine as desired. The single point electrode is attached to other side and held from 6 to 10 inches from the body of the patient at the point to be treated. Time of sitting, 10 to 15 minutes.	Local Sedation.
Multiple Spray	Same as "single spray" except that an electrode having a number of points is used.	Same as above to cover larger space.
Roller Massage	Jars on. Switch pointer on "spark." Patient attached to top of one of the jars, the other to roller electrode. The machine must be started with the prime conductors *actually touching.* They are then carefully separated until the resistance of the patient's clothing is overcome. NOTE. The current is milder when the jars are removed. In either case, however, the current must be applied *through the clothing* and not on the bare skin.	Counter irritation in cold joints. Massage.
Direct Spark	Jars on. Switch pointer on "spark." Patient attached to top of one jar—the other to ball electrode. The prime conductors are now separated 5 or 6 inches and the ball held close enough to the body of the patient to allow a spark to jump across. This treatment is painful.	Deep impressions to paralyzed muscles.
Induced Spark	Same as above, except that jars are removed. Not so painful.	Same as above counter irritation.
To find the polarity of a static machine	Start the machine in action and separate the prime conductors about ½ inch. The *white* end of spark indicates the *positive.* If now the prime conductors are pulled out several inches the heavy or white end of the spark is on the *negative* side. If the jars are on, the switch pointer must be on "spray."	
To attach the Crooke's Tube	The positive or anodal end of the tube terminates in a *flat* piece of platinum and extends to the middle of the tube. The negative or cathodal end is a *cup-shaped* piece of aluminum and does not extend into the bulb of the tube. The positive end of the tube must be attached to positive side of machine and the negative end to the negative side.	

CHAPTER XI.

ROENTGEN X-RAYS.

On December 4, 1895, William Conrad Roentgen read a paper before the Physico-Medical Society of Würzburg, in which he described what he called the "X-Rays."

The discovery at once claimed the attention of scientific men throughout the entire world, more particularly the medical profession, because it was early discovered that the bones could not only be plainly seen but foreign bodies, like bullets and other substances opaque to these rays, could be located within the body.

Although it has been 16 years since their discovery, we seem to be yet entirely ignorant of their true nature, although a great number of investigators have advanced theories more or less plausible, the generally accepted opinion being that they are some form of irregular longitudinal vibration.

In several respects they resemble light—by traveling in a straight line, affecting photographic films, exciting fluorescence, and not being deflected by a magnet—which has led to the popular theory that they are light waves, which, if they were visible, would appear beyond the violet end of the spectrum. They differ materially from light, however, in the fact that they cannot be refracted or polarized, do not affect the retina and pass through some substances which light cannot penetrate.

The X-Ray will pass through nearly every known substance, as flesh, bone, paper, leather and metals of various kinds when in thin layers. The denser metals absorb more of the ray than the lighter ones, as while aluminum is very transparent to the ray, lead and platinum absorb more than any other known metals.

Roentgen stated in his original communication that the transparency of different substances of equal thickness depends on their density, which is true of other substances than metals, as the transparency increases far more rapidly than the density decreases.

ABSORPTIVE POWERS ON HUMAN TISSUE.

As water is the chief constituent of tissue and its heaviest element is oxygen with an atomic weight of 16, it will absorb more of the rays than fat, which is lighter in its atomic weight and is more readily traversed by the ray. Muscle, tendon and nerve tissue differ very slightly from the atomic weight of water and absorb the ray at about the same ratio. Bone being rich in calcium, having an atomic weight of 40, will absorb nearly three times the amount of the ray as the rest of the tissues of the human body. Gases and air, owing to their low atomic weight, may be regarded as nearly transparent to the X-Ray.

THE DEVELOPMENT OF THE CROOKES' TUBE.

To Faraday belongs the credit of experimenting with tubes from which the air had been pumped, and to him we owe the terms "Anode" and "Cathode" as applied to the vacuum tube in use. Faraday revised the terms as applied by him to the poles of a battery to apply to the terminals of a vacuum tube—"Anode" to that terminal by which the current enters the tube, and "Cathode" that terminal by means of which the current finds exit from the tube.

Faraday discovered the ray given off from the cathode terminal and called it the *cathode ray*.

Following the investigations of Faraday came Geissler, who, by improving the pump, succeeded in getting a better vacuum in the tube, and experimented by exhausting the air and filling the tube with gases of various kinds, discovering that solutions and salts of various chemicals behaved in a peculiar manner when sealed in a vacuum tube and a current of electricity passed through it. Fluorescent effects of the most brilliant description were produced, and by making the tubes of different kinds of glass iridescent colors of a startling character were observed. Geissler turned his discovery to a commercial advantage by making display tubes for entertainment purposes, and in no small way deserves credit for attracting attention to this mysterious *cathode ray*.

Following Geissler came Professor Hertz, better known as the discoverer of the so-called *Hertzian waves,* used in wireless telegraphy. Hertz sealed into a vacuum tube photographic films covered by metallic figures, and demonstrated that the cathode ray had photographic properties. He also discovered that the cathode ray could be focused by curving the cathode disc, and that the ray could be deflected by means of a magnet.

The scientific world was startled in 1887 by the announcement of Sir William Crookes of the discovery of a new state of matter which he called *"radiant,"* which he elucidated by a most elaborate series of experiments, and the invention of some of the most wonderful vacuum tubes.

He conceived of matter as existing in a state of extreme attenuation, and to demonstrate his ground constructed a vacuum tube which was exhausted to the one-millionth part of an atmosphere, and by sealing into the tube, in the path of the cathode ray, a rotating vane was able to make it rotate in either direction at will by deflecting the cathode ray on alternate sides by means of a magnet, demonstrating to the scientific mind the fact that the cathode stream was made up of solid particles and that they were of sufficient weight and traveled at a high enough velocity to enable them to rotate the vane at a high speed while in their path.

He also discovered the fact that the mechanical energy of the cathode stream could be converted into heat by placing a piece of refractory metal in its path and bringing it to a sharp focus on the target by curving the cathode—the metal was brought to a red-hot temperature in a short time, and if sufficient energy was imparted to the tube the target would be melted, due to the bombardment of the particles in the cathode stream. The heat generated being caused by the sudden arrest of solid particles traveling at an enormous velocity, the impulse of the blow setting the molecules of the metal in rapid vibration.

By coating the inside of the tube with various salts, Crookes demonstrated the fact that the cathode ray would cause fluorescence, emitting a magnificent glow when a current was passed through the tube. By inserting in the path of the cathode stream but not brought to a focus a refractory piece of metal he observed that it would cause a shadow to be thrown upon the wall of the tube, thus proving that the stream was arrested by solid bodies in their path. By constructing the cathode of tin he caused a fine deposit of the metal to travel from the cathode and deposit itself upon the inner surface of the tube, and by making the cathode in different shapes he found it would deposit a stencil of its shape upon the glass, proving the actual transfer of solid particles from the cathode to the opposite wall of the tube. It was also found that, if the degree of exhaustion was carried so far that the gas was all removed from the tube, the electric current would not pass through it, thus proving that particles were necessary in the tube in order to obtain the cathode ray.

Phillip Lenard, a pupil of Professor Hertz, conceived the idea of sealing into the end of the tube opposite the cathode a thin piece of aluminum one millimeter in thickness and succeeded in bringing the cathode ray outside the tube, where he found it would reduce photographic salts, cause fluorescence and could be deflected by a magnet. He thus demonstrated that it would penetrate four inches of air, but by sealing on a tube opposite the aluminum window and exhausting the air from it he found the ray would pass four feet in the tube with rarified gas. The only reason he did not discover the X-Ray was because he did not use apparatus sufficiently strong.

Roentgen, while carrying out Lenard's experiments, discovered the mysterious radiation, which, after four months' investigation, he was compelled to call the *X-Ray,* owing to its being an unknown force that seemed to obey no known mathematical law.

He at first thought he had discovered a new form of light and endeavored to refract it by means of prisms made from rock crystals, vulcanite and metal prisms of various kinds, but was utterly unable to get a diffraction band. He did get a curious result when attempting to reflect the ray —he found that a piece of metal placed *beneath* a photographic plate would impress its form on the plate, but no difference was observed when the metal was polished or not. It has since been found that the image of the metal may be reflected or impressed on a plate when six inches from it, and a large dictionary between it and the sensitive film. This has been explained by physicists on the theory that the X-Ray, coming in contact with a hard, refractory substance, gives rise to other longitudinal rays similar in character to the X-Ray, that have photo-chemical qualities, and the phenomena observed as a reflection is supposed to be due to these rays sent off in the same plane as the metal lays in relation to the plate.

He found this unknown radiation would pass through substances opaque to ordinary light, and obeyed a law of absorption in flesh, leather, paper, bone, etc.; that the absorption was equal to the specific gravity of the substances through which it passed, so that the bones were conspicuous when viewed or photographed, owing to the calcium salts they contained increasing the specific gravity.

Roentgen detected the radiation at a distance of four feet from the tube, but by the use of our modern apparatus the writer has been able to detect the ray at one hundred and seventy-five feet from the generator by means of its fluorescent powers on the screen.

CORPUSCLES, SYNONYMOUS WITH IONS AND ELECTRONES.

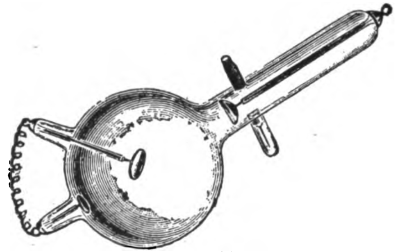
In order to understand the action going on in a vacuum tube we must know what is meant by these terms. Corpuscles are the component parts of any atom derived from any substance, and may be defined as the lowest form of chemical life, the indivisible residue left from the dissociation of atoms from any molecule. These corpuscles are endowed by physicists with certain characteristics possessed by no other substance in nature. They are represented as being ready to form chemical combination under the action of any stimulation, and possess the peculiar property of taking on and parting with a polarity when brought into contact with any polarized substance. It is this peculiarity that explains the cathode stream. On the passage of the current through the tube the ions are polarized and arrange themselves along the lines of force, making a passage for the current. On approaching the cathode terminal they have imparted to them a negative charge, and under the proven phenomena, that like poles repel like poles, are immediately shot off at a high velocity to the target, which is polarized positively. On reaching the target a violent blow is administered to it, and immediately the polarity changes and the ion is again shot off at the same speed with which it came. The process is constantly repeated until the energy of the blow delivered by the ion in its flight from the cathode to the anodal target starts the molecules of the target into vibration, rapidly heating it and giving rise to the peculiar vibration known as the X-Ray. The smaller the number of ions within certain limits the more rapidly they travel, and by imparting a heavier blow to the target give rise to a more rapid vibration of the molecules of the metal, making a ray of greater wave length that will travel a greater distance from the tube. This ray has greater penetrating force, but loses rapidly its photo-chemical efficiency until, in one high tube owned by the writer, it was completely lost. For the present it may be said that the X-Ray is formed by the sudden arrest of the cathode stream by some refractory substance in its path, which may be a metallic target or even the walls of the tube.

CHAPTER XII.

THE CROOKES TUBE.

The tubes that were used at the time of Roentgen's discovery were the well-known pear-shaped variety of Sir William Crookes' experimental outfit, and were without a metallic target. The cathode rays were not brought to a focus but were diffused over the opposite end of the tube. We were unable to use much energy with a tube of this kind, owing to the heating effect on the walls of the tube from the bombardment by the cathode ray, and consequently on the anouncement of Roentgen's discovery a determined attempt was made to perfect a tube that might be used to obtain more powerful effects. The results can be judged by the statement that, while it took about two minutes to photograph a hand with the original pear-shaped tube, the denser parts of the body can now be taken in a few seconds.

The first improvement in the development of a modern tube consisted in placing a platinum target in the path of the cathode ray, which was brought to a sharp focus, making it possible to invade all parts of the body with the ray. Still the exposures were un-



German Tube.

duly prolonged and the results doubtful, owing to the thin target developing sufficient heat to melt it when the current was pushed beyond a certain point. By increasing the size of the target and constructing it of other metals the energy of the largest apparatus may now be sent through them without danger for at least two minutes—long enough to obtain the most difficult skiagraph.

The extensive use of the new tubes has demonstrated the fact that the degree of exhaustion is increased rapidly on large apparatus until after a few hours' use the vacuum increases to such a point that the exciting current can no longer be forced through it. Makers have therefore been compelled to experiment to find some method of regulating the vacuum in a tube while it was in use.

VACUUM TUBES.

Let us study for a few minutes the meaning of the term *vacuum,* and in order to do so we must take up the molecular theory briefly in order that we may have a working knowledge of the subject.

We know the atmosphere is under a pressure of about fifteen pounds at the surface of the earth; therefore let us conceive of the atmosphere being composed of spherical bodies—called molecules—held together by this pressure. The pressure being great, considerable friction is caused by their movements and it is this fact that prevents the atmosphere from becoming a good conductor of electricity, but by enclosing these molecules in the rigid glass walls of a tube and applying a pump to remove the pressure and a certain proportion of the molecules it is found in practice that, as the exhaustion is continued and the molecules separated from each other they become better conductors of electricity, and, while the first spark sent through the tube is white and zigzag and emits a crackling noise, it soon changes to a deep purple and passes noiselessly directly from one terminal to the other. We know that molecules are again subdivided into bodies called atoms, and by carrying our exhaustion far enough we cause a complete breaking up of the molecular form and liberate the atoms in the tube, and as soon as this occurs the character of the electric discharge changes; sparks disappear from the tube and a bluish glow takes their place, and we have what is known as a *Geissler vacuum.* By increasing the degree of exhaustion and removing more of the atoms the discharge changes again in character and a bluish white discharge takes place in the tube. Now it at once becomes apparent to the reader that physicists would be unable to explain certain phenomena connected with electricity, especially in regard to vacuum work, without again subdividing the atoms into *corpuscles,* of which each atom contains a great number. So when the exhaustion is carried still farther by means of the mercury pump we cause a dissociation of atoms and liberate corpuscles in the tube, when it is said to have *crossed the line,* and the entire character of the phenomena changes. A dividing line is now formed opposite the plane of the target and the color changes from a bluish white to an apple green, if uranium is contained in the glass; or, in certain other kinds of glass, a yellowish color is given off. The cathode stream may be seen focused in the target as a bluish ray, and by viewing the tube through a screen, to be described later, slight fluorescent effects are noted, and the shadow of the hand may be seen as it passes back and forth before the screen. By continuing the action of the pump it is seen that the fluorescence of the screen increases in brilliancy until the bones stand out in bold relief, while the flesh is transparent. The cathode ray now becomes invisible—all blue light having disappeared from the tube—and by continuing the process of pumping and separating the corpuscles more and more, giving them a chance to travel at a higher rate of speed, the bones have become illuminated and are transparent to the ray as viewed on the screen, and eventually a degree of exhaustion is obtained where the bones and flesh are so transparent that the image of them entirely disappears.

The degree of exhaustion has great importance with reference to the purpose for which the tube is to be used. When the tube has *crossed the line* and is full of corpuscles considerable friction is caused by their movements. They travel at a slower velocity and the tube is said to be *low* or *soft* and the wave length is shorter—consequently while it is rich in photo-chemical effects it does not have velocity enough to penetrate the tissues to any great depth, but by removing more of the corpuscles by means of the pump we increase the speed at which they travel by reducing the friction element, and a longer wave length is given off, which penetrates the tissues more deeply, still retaining, however, its photo-chemical action somewhat diminished, and we call this a *medium* tube.

By long use we exhaust the tube of more corpuscles by compelling them to unite electrolytically with the metal of the cathode or anode, and, in some tubes, with the glass walls, and after a certain amount of use it is found that the bones when viewed on the screen have disappeared as well as the flesh and a slight shadow only is noticed when the hand is passed before the screen. Bright patches of green can be seen in different parts of the tube and the current shows a disposition to spray off the conducting wires, at times to even jump over the tube. It is then said to be *high* or *hard* and is practically useless for further X-Ray work until it has been submitted to a process that will restore to it more corpuscles.

METHODS OF REGULATING TUBES.

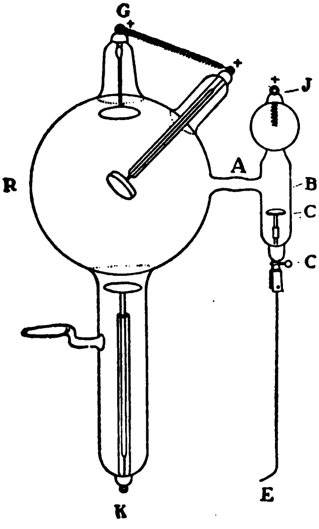
The first successful way of reducing the vacuum of a tube that had become *hard* was by the simple procedure of placing it in a cold oven, wrapped in fire felt and by gradually increasing the temperature until about 480° F. are obtained, which is sufficient to drive the corpuscles from the chemical formations they have formed with the walls of the tube. They are now at liberty to again circulate under the influence of the current. It has been found in practice that baking a tube reduces it *below* the line, so that it is best to remove the tube from the oven as soon as perfectly cool and put it on the coil. When the current is first turned on a bluish white light is seen, but if run steadily for twenty minutes the line will appear and green light is noticed. The X-Ray may be seen coming and going by flashes, but by continuing the process a short time they remain permanent and the current may be turned off. The time of usefulness gradually diminishes after each treatment until at last the tube must be opened and repumped. Another useful way with cheap tubes is to reverse the poles and run the current backward for nearly one hour, when sufficient corpuscles are driven off from the cathode electrode to restore the tube to usefulness for a short time.

These methods being attended with considerable work, beside not reducing the tube to any exact point, gave rise to a demand for something automatic and brought out the "Sayan Regulator," now universally known as the Queen patent regulator. Sayan, in his experiments, took advantage of the well-known fact that caustic potash absorbs moisture under all conditions and will part with it under the influence of heat, so he constructed an auxiliary tube of small resistance and focused the cathode ray upon a small platinum anode, which carried a wire through the glass into a tube of caustic potash. By pumping the large tube to a very high vacuum he made its resistance too high for the current to pass; consequently it passed through the small tube first, causing the anode to become red-hot by the bombardment of the cathode ray and by transmitting the heat from the wire to the potash bulb moisture was driven off, lowering the vacuum in the large tube. In order to have a wide range of regulation a shunt spark gap was attached to the cathode of the small tube and by adjusting it at a variable distance from the cathode terminal of the large tube more or less vapor was driven off as required and the vacuum in the large tube was completely under control. The smaller the spark gap the lower the vacuum in the large tube, and by having the spark gap set at a certain distance the vacuum of the large tube would remain stationary, as a spark would pass over the shunt from time to time, driving more moisture into the large tube as needed. As soon as the tube cools the moisture is again absorbed by the potash and the large tube regains its former high vacuum. This tube is the finest in principle of any of the so-called regulation tubes. Unfortunately, however, Queen & Co., with a lamentable lack of enterprise, did not construct them large or strong enough for the more powerful apparatus. These tubes can be run for hours on a light current, maintaining their vacuum steadily, and are ideal for treating purposes, but the anode can be melted in less than one minute when used for skiagraphic purposes, because, although made of heavy platinum, its bulk is small and does not conduct the heat off as fast as formed. Care should be used with this tube not to place the shunt nearer than one inch or the tube will speedily become black and ruined for all purposes.

A modification of this same principle was used by the Edison General Electric Company Lamp Department for a short time by enclosing a stick of potash in a bulb connected with the large tube and heating it by means of an alcohol lamp when the tube was used. The difficulties encountered owing to the breaking of the glass by the injudicious application of heat and reducing the vacuum too far for practical use led to its being abandoned shortly for another tube containing a copper salt that gave off oxygen by direct connection with the current. This method is used to-day with the addition of a muffled spark gap containing some barium salt, which, by lowering the resistance of the shunt, causes the current to pass through the regulator, driving oxygen gas into the tube, which lowers its vacuum by setting the shunt at a certain point, making the vacuum stationary as long as required. The arrangement is very fine and gives good satisfaction in practice.

A good regulator comes to us from a foreign land made by Mr. Carl Mueller, of Germany. He has constructed his anode of selenium-iron, a very refractory alloy of iron, and one that does not give off much gas under the influence of the current. The anode is made very large in order to absorb the heat and the regulator contains some salts that give off nitrogen gas under the influence of the current when connected with the negative wire. The tube may be reduced in a few seconds as far as required under a weak current, and, unlike the other tubes, maintains its vacuum for a considerable time afterward. As these tubes come to this country they have a shunt spark gap similar to the Queen patent for constant regulation. A unique feature is a means of raising the vacuum as required; this is accomplished by putting into the regulator an iridio-platinum spiral wire, which under the influence of the current from positive wire throws off nascent platinum in a fine shower which absorbs the free corpuscles, gradually raising the vacuum in the tube. Usually five minutes is required to bring a tube from a low to a very high vacuum. These tubes will stand the current from the heaviest apparatus for two minutes without danger, the only serious drawbacks being the initial high price and the fact that so many tubes are sent out by the manufacturer that are not annealed, causing them to break on cooling after use. Below we give illustration and description of the Mueller tube.

The secondary tube B is joined to the main tube R (see figure) by means of a short tube A; the air space of B is in direct connection with that of R. B is supplied with a cathode C made of a substance which, as soon as the current is conducted through B in the direction shown, immediately delivers a certain quantity of gas, thus reducing the hardness of the tube. The conduction of the current through the secondary tube is effected by approaching to a certain air-distance the brass bar E, which is connected with the cathode C and movable on it by means of a turning-joint to the cathode in the main tube K; this distance to be from about two to three inches if the X-Rays are to be applied to a pelvis and from about one to two inches if to a hand.



MUELLER TUBE.

The regulation is proved by the electricity passing as a current of sparks between K and E.

Another foreign-made tube with an electric regulator is the Voltohm. It is in most respects a very fine tube and will stand a very heavy current for a long time, but the regulator is not worthy of the name. The anode is made of copper covered with a thin platinum layer and causes considerable annoyance by giving off gas for several weeks, when suddenly it runs too high in vacuum and the regulator must be used; this is accomplished by connecting the positive wire to it, and it may take thirty minutes to reduce it to a state of usefulness. After a few times the regulator will not work and the tube must be baked to regain the required vacuum.

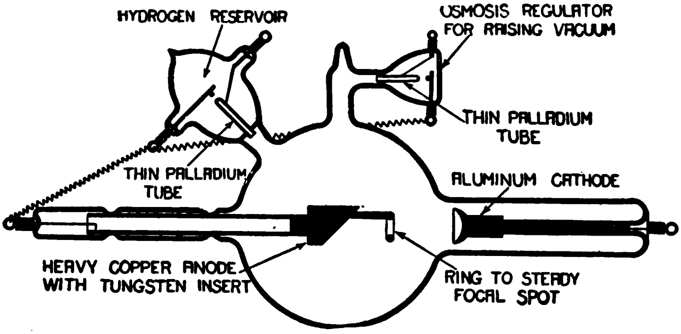
The Gunlach tube is another ideal tube for skiagraphic work, as it will stand the heaviest current for five minutes without danger. The anode is constructed of steel, which has an enormous radiating surface to conduct off the heat as it is generated. The regulator consists of a metallic stem inserted in the glass surrounded by some salt, and by heating the stem gas is driven off. It works perfectly a few times and then resort to baking must be had.

In treating the various lesions for which the Roentgen ray is indicated it is absolutely necessary that the tube be of proper vacuum and penetration to reach only the seat of lesion. Such diseases as epithelioma, lupus, acne and eczema require a tube of low vacuum because the seat of the trouble is not deep. Deeper seated malignancies, however, such as cancer of the breast, stomach or uterus call for a tube of much higher vacuum.

The most ordinary way for testing the tube vacuum—and one which is sufficiently accurate—is by the length of spark gap the tube will back up. The testing should always be done with the same generator we intend to use to excite the tube for the treatment, and may be either static machine or induction coil. It must be remembered, however, that after testing the vacuum of the tube on the static machine such tube cannot be used on the coil and give the same results. A tube that is too low to use with static machine is oftentimes too high for the coil and vice versa.

Attach the tube to the generator by suitable conducting cords with the anode to the positive side, the cathode to the negative. Be sure there are no spark gaps in the circuit. Start the machine with the prime conductors actually touching each other, then gradually separate them until the sparks cease to pass, which shows that the current is now passing through the tube. The distance the prime conductors are apart when the resistance of the tube is overcome, or when the sparks cease to pass between them, is the length of spark gap the tube will back up, and indicates its vacuum.

A tube that will back up a one inch spark gap is low or "soft." One that backs up two or three inches is "medium" and one four or five inches is high or "hard."


HYDROGEN RESERVOIR
OSMOSIS REGULATOR FOR RAISING VACUUM
THIN PALLADIUM TUBE
THIN PALLADIUM TUBE
ALUMINUM CATHODE
HEAVY COPPER ANODE WITH TUNGSTEN INSERT
RING TO STEADY FOCAL SPOT

HYDROGEN TUBE.

The most recent type of X-ray tube to be placed on the market is known as the hydrogen tube.

It differs from other tubes by the use of hydrogen gas only, which is introduced into the main bulb and removed therefrom by taking advantage of the peculiar property of red hot palladium, which allows hydrogen to pass through it readily and, at the same time, hinders or completely obstructs the passage of other gases.

A palladium tube mounted within the "reducer" bulb charged with hydrogen is heated by passing the high tension current between a spark rod and the end of the palladium member placed ⅛ of an inch apart. Thus heated, hydrogen passes through the palladium member into the main bulb, reducing the vacuum.

The palladium tube of the "raiser" is exposed to the atmosphere, consequently heated hydrogen diffuses outward from the main bulb into the atmosphere, thus raising the vacuum. It is the only tube embodying this novel feature of raising the vacuum by extracting gas from the main bulb and discharging it into the atmosphere.

The high electrical conductibility of hydrogen gas compared with other gases reduces the resistance to the current flow and likewise gives relatively higher penetration for a given parallel spark as compared with other types in which there is a mixture of elements and complex gases, the resistance of which fluctuates spasmodically.

The vacuum is maintained well under heavy exposures. There is comparatively little sputtering of the tungsten target in hydrogen gas as compared with other gases. A novel feature of the cathode is a steel shell which prevents direct heat radiation to the cathode neck and rigidly supports it. The eyelet extending from the anode serves the purpose of steadying the focus and tends to distribute heat uniformly around the cathode neck.

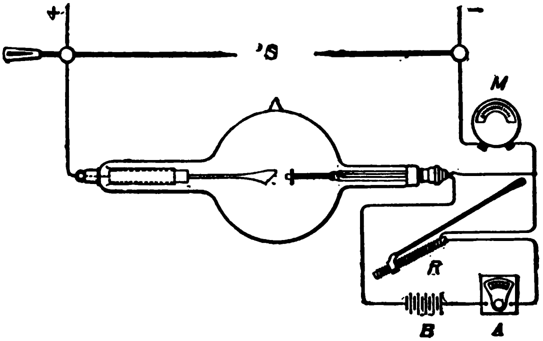
In making several thousand exposures, hospital records show long life and uniform characteristics, after which it is found to act substantially the same as when new. Its special field of application is that of Roentgenotherapy.

COOLIDGE X-RAY TUBES.

The Coolidge tube differs in principle from other X-ray tubes in that the discharge current is determined primarily by the temperature of the cathode filament and responds instantly to the changes in the same in either direction.

The intensity and penetrating power of the Roentgen rays produced are both under the complete control of the operator, and can be instantly increased or decreased independently of each other.

The tube can be operated continuously for hours with either high or low discharge currents without showing an appreciable change in either the intensity or the penetrating power of the resulting radiations.



Coolidge Tube, Showing Cathode Control.

In operation it shows no fluorescence of the glass and no local heating of the exterior hemisphere.

The Coolidge tube consists of a tube exhausted to a pressure of not more than a few hundred millionths of an atmosphere in which is supported the cathode and anode, both being thoroughly freed from gas.

The cathode consists of a closely wound spiral of tungsten wire mounted concentric with a cylindrical tube of molybdenum which acts as a focusing device. This cathode is so arranged that it may be heated from an independent electrical source, such as a low voltage transformer or storage battery. The anti-cathode, or target, which also serves as anode, consists of a single piece of wrought tungsten attached to a molybdenum rod and supported by a split iron tube. The important characteristics of the Coolidge tube, other than those already mentioned, are as follows:

No discharge current passes through the tube unless the filament is heated.

The starting and running voltages are the same.

The focal spot is fixed in position.

The allowable energy input is determined by the size of the focal spot.

It permits of the intense primary Roentgen rays of any desired penetrating power.

The Coolidge tube is delivered with three sizes of focal spots—fine, medium and broad.

The fine focus tube is recommended for fluoroscopy and radiographic work where sharp detail is desired, and heavy currents are not required.

The medium focus tube will be found suitable for most radiographic, fluoroscopic and light therapeutic work.

For deep therapy and radiographic work, where heavy currents are required, broad focus tubes should be used.

On account of the allowable energy input being determined by the size of the focal point it is advisable to keep the amount of current used within the following limits, and by so doing the operator is, in general, assured of satisfactory operation and the longest possible life of the tube.

Fine focus tubes should never carry over 25 milliamperes. The medium focus tube should never carry more than 45 milliamperes. The broad focus tube should never carry more than 75 milliamperes.

The backup spark used with the above amount of energy should never exceed 6 inches, and if possible it is always advisable to start exposures with the target cold.

NEW SMALL TYPE COOLIDGE X-RAY TUBE.

The bulb of this tube has a diameter of 3¾ inches, which is one-half the diameter of the standard Coolidge tube—the length, however, of each being the same.

It has a very fine focal spot which renders it particularly valuable to the roentgenologist in that it enables him to obtain very fine detail in fluoroscopy and radiography where heavy currents are not required. It is, however, not recommended for therapeutic work.

On account of the extra fine focus of this tube the maximum current and energy which can be safely used to operate it is necessarily low. It is recommended that not more than 10 milliamperes with a 5 inch backup spark be employed. In using this amount of energy, the tube can be run continuously with safety. The number of milliamperes, however, may be increased by decreasing the backup spark, but it would not be advisable to use over 15 milliamperes with a 3 inch backup spark. Corresponding increase in backup spark means also a lowering of the milliamperage, and it would not be advisable when using a 7 inch backup spark to use over 5 milliamperes.

CHAPTER XIII.

RADIOGRAPHIC RUDIMENTS.

Many forms of apparatus have been used for exciting the X-ray tube, but the interrupterless transformer is now acknowledged by good operators as best suited for this work. It is to be supposed then that the reader has some one of the many types of interrupterless transformer, and a good gas tube, such as has heretofore been mentioned.

In giving the rudiments for taking radiographs no attempt will be made to interpret the findings, as this is in a class by itself and must be learned from works on that subject, or better still, under the personal instruction of a good Roentgenologist.

One of the first requisites in making a radiograph is to have a perfectly dark room into which no ray of white light can enter. If the dark room is so situated that a window opening out of doors can be had, the window can be covered completely with black opaque material into which is cut openings for two panes of glass, one of ruby, the other orange. These will so modify the light that there will be no danger of "fogging" an X-ray plate.

The second essential is a good ruby photographic lamp through which no white light will leak. An electric lamp is the best form to use owing to the fact that the oxygen in the room will not be used up, causing it to become close and suffocating, neither will there be smoke which is very annoying to the operator.

An X-ray plate is one of the most sensitive of photographic plates and any exposure to white light or X-rays, even though at quite a distance from the machine, will cause a fog on the plate which will spoil the nicer detail of a picture. These plates come in a light-proof box which has two compartments. Furnished with them are black and yellow light proof envelopes. On the front side of the yellow envelopes are spaces for data relative to pictures which have been taken. Open the box of plates in the dark room, using only the ruby light. Place the plate film side up in the dark envelope first, arranging it so the film side will be toward the front, or the fold of the envelope will close on the glass side of the plate. To distinguish between the film side and glass side of the plate, hold it at an angle toward the ruby light. The film side will be dull and the glass side reflect brightly. When placing the plates in the envelopes without light, test the surface with the wet finger, the glass side will slip and the film side will stick.

After having placed the plate in the black envelope, put it into the yellow one with the film side toward the back of the envelope, turning the fold back once more. The plate and the black envelope should be placed in the yellow one with the fold at the bottom. By so doing there will be no danger of light leaking through the folds. Do not put more plates in the envelopes than are to be used immediately as the black envelopes contain a certain amount of sodium hyposulphite. This causes a deterioration of the film should they remain in them a few days, consequently it is advisable to fill the envelopes just before taking radiographs and then immediately develop them. We are supposing now that the plates are ready for taking the X-ray picture, with the film side toward the back of the envelope.

Before removing the plates from the lead-lined box in the dark room see that the tube is properly tested out and the machine adjusted to give exactly the number of milliamperes through the tube and the proper spark gap for penetration that you would require for the radiograph about to be taken.

Much of the success of making a good picture will depend upon the plates. Some plates are much more rapid than others. The ones in general use are: The Diagnostic, Paragon, Victor, Seed and Cramer. The speed being in the order in which they are here given.

The technic for some of the simpler radiographs follows:

Colles Fracture.—The patient extends the arm upon the table with the palmar side of the hand up, the tube centered over the wrist, at a distance of 16 inches from the target; spark gap, 5 inches; time of exposure, ½ second, with 30 milliamperes through the tube. This technic is for Diagnostic, Paragon, Victor or Seed plates. If, however, the plate to be used is a Cramer, or slower plate, the spark gap should be decreased to 4 inches; the current through the tube increased to 50 milliamperes, with a distance from the target of 20 inches, and increasing the time to 1½ seconds. Two views, at least, should be made in every case.

The Knee.—Using a rapid plate, we employ the same technic as for Colles fracture, except the time, which is increased to 2 seconds. If the Cramer, or slower plate is used, the same difference of technic must be employed as noted above. In every instance the plate is placed with its center directly under the part to be taken, film side up.

As the same difference in technic exists in every instance between the Paragon, Diagnostic, Victor or Seed and the Cramer plates, the technic hereafter will be given for the rapid plates only.

The Hip.—We center the principal rays at a point about 3 inches below the crest of the ilium, at a distance of 18 inches from the target to plate. In this exposure the spark gap should be 6½ inches, with 80 milliamperes through the tube, and the time 1 second.

The Shoulder.—In making this radiograph the rays should be centered a little inside and above the axilla. After the plate has been placed under the shoulder, a pillow should be placed under the other shoulder, thus making the part to be taken lie closer to the plate. The spark gap should be 5 inches, with 40 milliamperes flowing through the tube at a distance of 20 inches; time required, 3 seconds.

Clavicle.—In making radiograph of this bone, the patient should take the prone position, and the principal rays centered over the spinous process of the third dorsal vertebra. All respiratory movements should cease, the patient being asked to hold the breath during the time of exposure. In this picture a 5-inch spark gap is required, 50 milliamperes through the tube, at a distance of 20 inches; time, 1½ seconds.

Dorsal Spine.—The rays should be centered over the sixth dorsal vertebra, the patient, of course, lying on the back, and using a plate large enough to reach from the seventh to the twelfth dorsal. Spark gap should be 5 inches, with 40 milliamperes through the tube, at a distance of 36 inches; time required being 11 seconds.

The Ribs.—The patient should be in such a position as to bring the supposed fracture as near the plate as possible. The author is accustomed to use a wire ring about two inches in diameter, the wire being about as thick as a 50 ampere fuse; in fact, fuse wire is the best substance to use and shows up well on the plate on account of containing so much lead. This ring is placed upon the patient so as to enclose the supposed fracture, and fastened with a strap of rubber adhesive plaster. Place the tube so that the principal rays will be over the wire ring, patient being instructed to hold the breath during time of exposure. Spark gap, 6 inches, with 50 milliamperes through the tube, at a distance of 20 inches; time, 1½ seconds.

CHAPTER XIV.

DENTAL RADIOGRAPHY—POSITIONS.

Always bear in mind, that Radiography is Shadow Work. and that Angles have a most important bearing on results. Far too often the X-ray tube is tilted too high, or allowed to drop too low, with the result that the images on the negatives are distorted: some lengthened, and some shortened. If you will study the Figs. Nos. 1 to 8, you will notice that in order to produce a result on which the images are neither lengthened nor shortened, the rays must strike the film at nearly (but not quite) a right angle. The following are illustrations of Uppers:

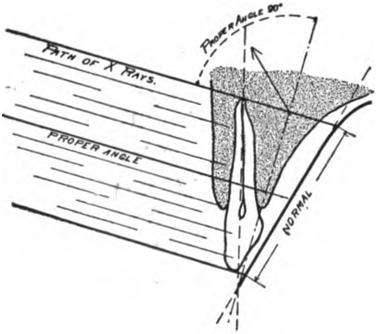


FIG. 1.

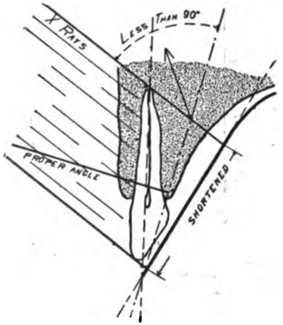


FIG. 2.

Fig. No. 1 shows position of film and angle of ray adjusted properly. Result will show normal length of tooth.

Fig. No. 2 shows angle of ray when tube is tilted too high. The image on the film will be too short for proper diagnosis.

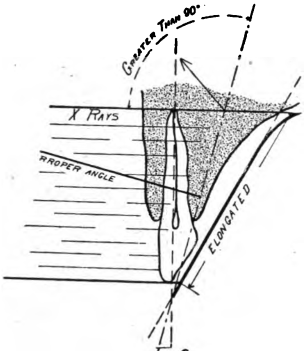


Fig 3

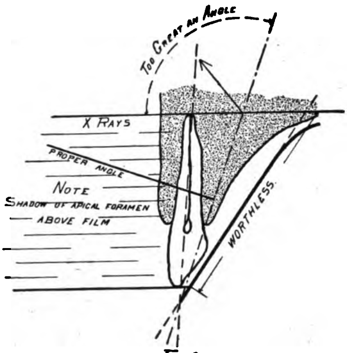


Fig 4

Fig. No. 3 illustrates position with tube too low. The resulting image will be too long.

Fig. No. 4 illustrates position of tube so low that the shadow of the apical end of the tooth passes over the top of the film. The resulting negative is worthless.

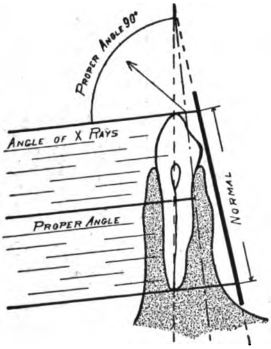


Fig 5

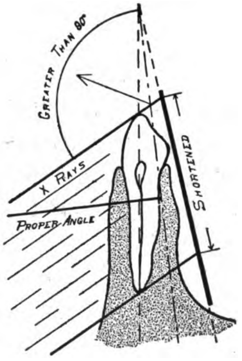


Fig 6

Practically the same arguments hold good on Lowers as on Uppers, with the exception that too high an angle on the tube will produce lengthening, and too low, shortening.

Fig. No. 5 illustrates proper angle of ray for Lowers. Also proper position of film.

Fig. No. 6 illustrates angle of ray when tube is placed too low. The resulting image of the tooth will be considerably shortened.

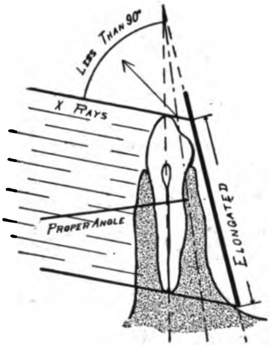


Fig 7.

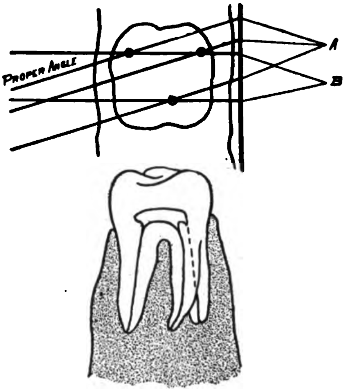


Fig 8.

Fig. No. 7 illustrates angle of ray with tube too high. The resulting image on the negative will be lengthened.

In order to show all three roots of molars clearly, it is necessary to make two or even three exposures, from different angles; that is, figuring from front to back. This point you will find illustrated on Fig. No. 8.

Fig. No. 8 shows both lateral view of molar and view of top of crown. You will note, from the lines drawn through the approximate positions of the roots, the different results that may be achieved by using various angles. "A" indicates proper angle for picturing all three roots. "B," indicating position of tube and resultant angle of ray, will show but two roots clearly, with the third rather indistinct.

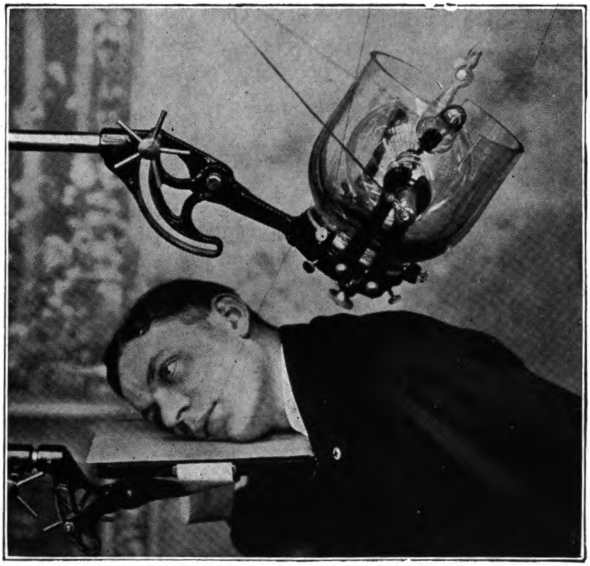


FIG. NO. 11.

Fig. No. 11 shows position of patient and tube for making radiograph of mandible of right side; also takes in teeth as shown on Fig. 12.

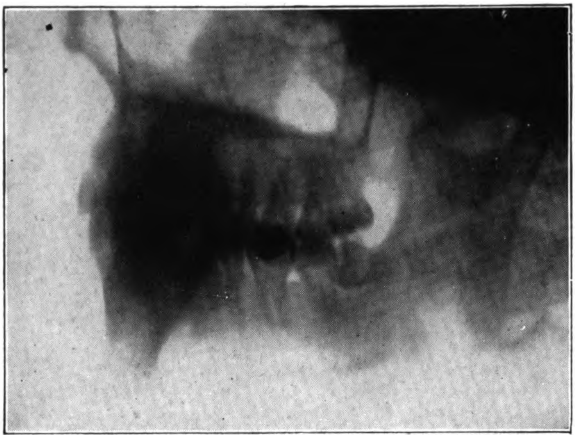
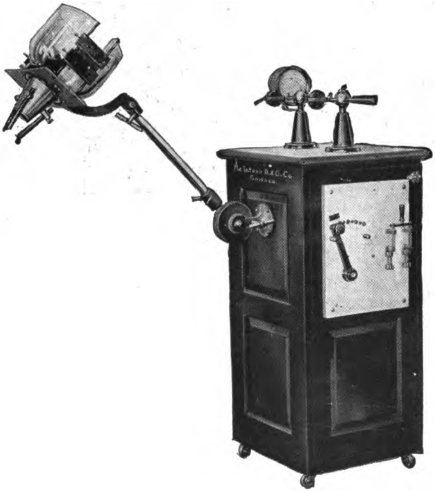


FIG. No. 12.

Fig. No. 12 illustrates the result from position No. 11.



AN IDEAL APPARATUS FOR
DENTAL RADIOGRAPHY.

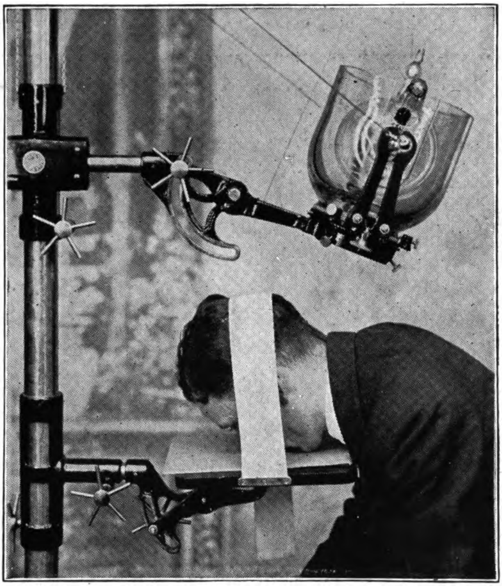


FIG. No. 13.

Fig. No. 13 shows proper position for making radiograph of the antrum of Hymore through back of neck; also the centrals and laterals. (See Fig. No. 14.)

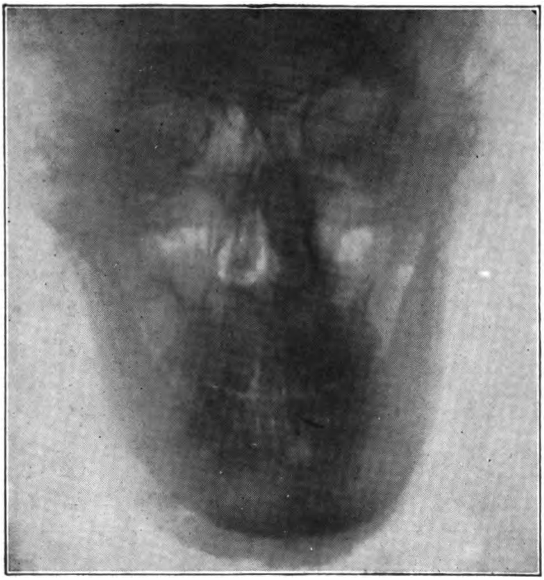


FIG. NO. 14.

Fig. No. 14 illustrates the result from position No. 13.

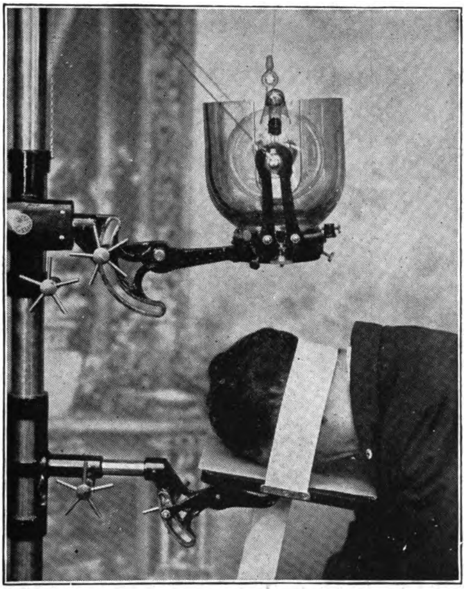


FIG. NO. 15.

Fig. No. 15 shows position for making radiograph of the frontal sinuses and antrum of Hymore through back of head; passing rays in line over top of ear and in line with orbits. (See Fig. No. 16.)

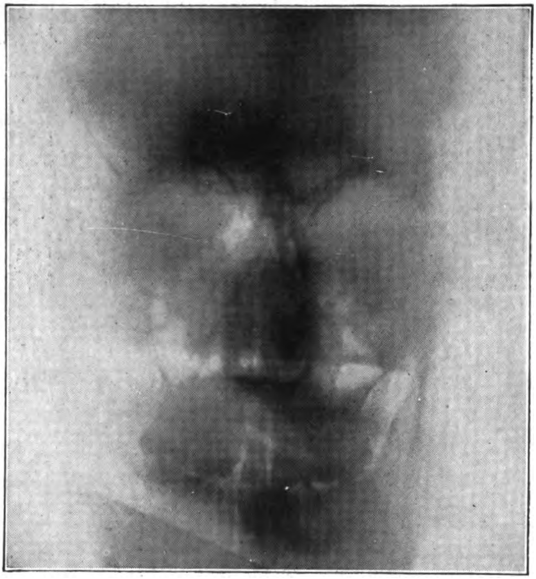


FIG. No. 16.

Fig. No. 16 illustrates result from position No. 15.

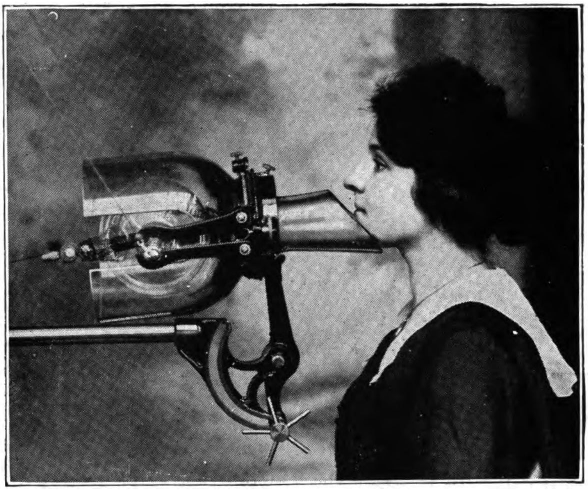


FIG. NO. 17.

Fig. No. 17 shows position for making film radiograph of lower centrals and laterals. Head tilted back slightly, tube support tilted all the way back. (See Fig. No. 18.)

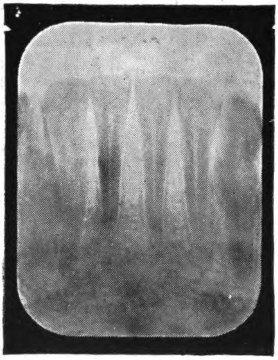


FIG. NO. 18.

Fig. No. 18 illustrates result from position No. 17.

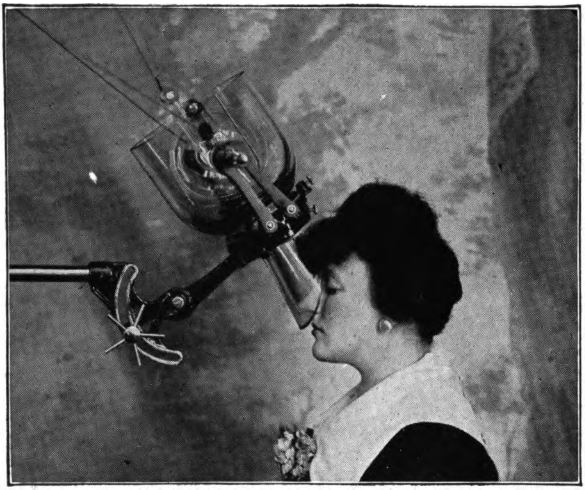


Fig. No. 19.

Fig. No. 19 shows position for making radiograph of upper centrals and laterals. Cut edge of cone parallel with face. (See Fig. No. 20.)

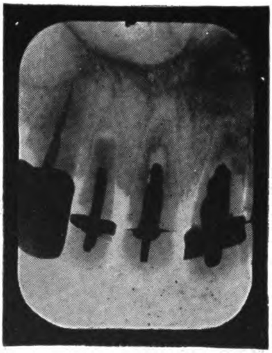


Fig. No. 20.

Fig. No. 20 illustrates result from position No. 19.

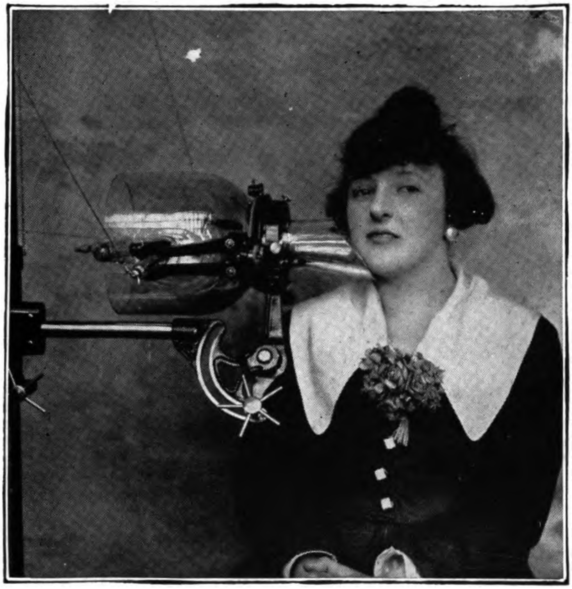


FIG. No. 21.

Fig. No. 21 shows position for making radiograph of lower molars. Head held upright, chin resting in hollow of cone. (See Fig. 22.)

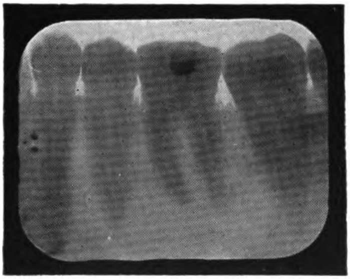


FIG. No. 22.

Fig. No. 22 illustrates result from position No. 21.

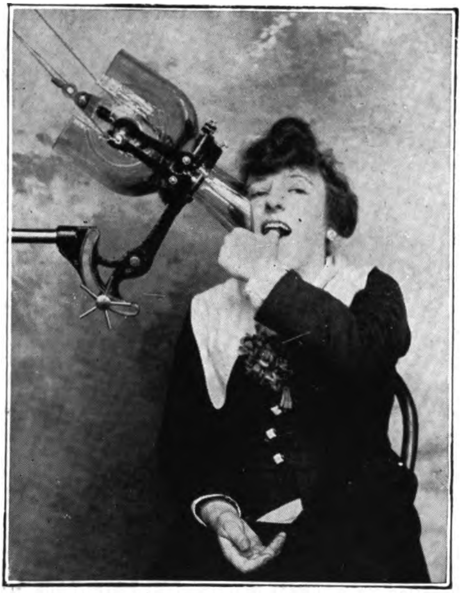


FIG. No. 23.

Fig. No. 23 shows position for making radiograph of upper molars. Cut edge of cone parallel with face. (See Fig. No. 24.)

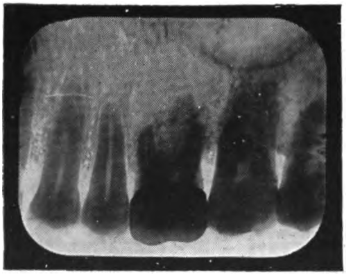


FIG. No. 24.

Fig. No. 24 illustrates result from position No. 23.

CHAPTER XV.

THE ROENTGEN EXAMINATION.

GASTRO-INTESTINAL TRACT.

It is desired, in this chapter, to bring before the General Practitioner and the Roentgenologist a brief outline of the technic, normal appearance and pathological findings commonly encountered in the routine X-ray examination of the Gastro-Intestinal Tract.

Technic.—

PREPARATION.

An Empty Stomach, by fasting over night and omitting breakfast, before the Opaque Meal.
An Empty Colon, by cleansing enamata.

Cathartics are less desirable, as they may cause abnormal peristalsis, especially in Colon study.

Opaque Meal.—Barium Sulphate, 4 ozs.
Buttermilk, 1 pt.
Opaque Enemata.—Barium Sulphate, 6 ozs.
Thin starch paste, 1¾ pts.

First observation is made during and immediately after the ingestion of the opaque meal. The Roentgenoscope is used in the vertical position followed by serial Post-Ant. plates in the horizontal position. Lateral plates may also be taken and the horizontal Roentgenoscope used in doubtful cases. The Esophagus, Stomach and Duodenum are the structures under observation.

Second observation is made six hours after the meal with the Roentgenoscope and one or more plates, paying especial attention to the residue of the opaque meal in the Stomach and Duodenum. The structure of the Terminal Ileum, the Caecum and Appendix are also in the field of observation.

Third observation is made twenty-four hours after the opaque meal at which time the entire Colon is studied. The Colon study is completed by the administration of the opaque enema, using the horizontal Roentgenoscope and serial or stereoscopic plates of the entire Colon.

Some workers use a two meal method, the first given six hours before, and the second at the time of the first observation. This requires only two observations, but we have not found it as satisfactory as the single meal technic.

ROENTGEN ANATOMY AND PHYSIOLOGY.

The Esophagus.—A collapsible tube, easily distended by obstruction, with three narrowed portions, at the Introitus, at the left Bronchus and at the Cardiac Orifice. Down this tube foodstuffs rapidly pass from the Pharynx to the Stomach. The standard opaque meal requires about two seconds in the average person, while more viscid or semi-solid foods may require seven to eight seconds. For special study of the Esophagus the opaque meal is modified by adding powdered Acacia and using less buttermilk.

Stomach and Duodenum.—The opaque meal, after a momentary pause at the Cardiac Orifice, passes in a continuous stream along the lesser curvature, gradually filling the empty pouch until it becomes recognizable as a stomach. It varies greatly in appearance from the hypertonic type resembling an inverted cow's horn in the vertical position, to the atonic type resembling a boxing glove placed horizontally.

The position of the stomach varies with the type; the hypertonic type placed high is protected from easy palpation by the Costal Arch, while the atonic is low in the abdomen or pelvis and can be freely moved about by palpation.

As the opaque meal distends the stomach, the following landmarks are looked for:

The Cardiac Incisura, a slight depression above the Cardiac Orifice. Draw a line through the depression horizontally—the portion above the line is called the Cardiac portion; below the line is the middle portion or body of the stomach, extending with its lesser and greater curvature as far as the Incisura Angularis, called by some the Prepyloric Sphincter. This is a depression in the lesser curvature, a few inches in front of the true Pyloric Sphincter, and divides the body of the stomach from the pyloric portion. The more or less oval termination of the pyloric portion is called the Antrum. The Pyloric Sphincter is from one-eighth to one-quarter inch in width, beyond which is the smooth rounded first portion of the Duodenum, called the "Cap," or Bulbus Duodeni. The walls of the first portion are smooth and regular, like the stomach, and are very favorable for X-ray demonstration, while the second and third portion take on the irregular serrated appearance of the small intestine.

The opaque meal in the remainder of the small intestine in the normal case shows only as flaky masses, and the lumen of the intestine does not show except in cases of obstruction, until we reach the Terminal Ileum. At the six hour observation, or after the opaque enemata, the folds of the Terminal Ileum can be satisfactorily demonstrated.

The Colon.—In the usual Gastro-Intestinal Examination the study of the Colon is slighted, because it comes last, no doubt, and because of the objection some patients make to the opaque enemata, until our assistant demonstrates how easily it can be given with the low gravity method. The anatomy of the normal Colon is familar to all, and can be demonstrated by the opaque meal as it passes, but more startlingly by the opaque enemata, which should always be used.

We wish especially to call attention, first, to the four normal types of Caecum, according to the classification of Treves; second, to the great range of mobility of the transverse Colon; third, to the wide variation of the three sigmoid loops.

Peristalsis is a constant and interesting factor in Colon movement; it is most pronounced in the last half of the Colon. Anti-peristalsis is the chief factor in Colon movement. These reversed waves commence in a narrowed portion, near the middle of the Transverse Colon, and increase in strength until the pouch of the Caecum is reached. It is this movement that takes up the opaque enema when the low gravity method is used, and quickly fills the entire Colon, even forcing it through the Ileocaecal valve into the Terminal Ileum in one-fifth of the cases. This last observation is called by some "Ileocaecal incompetency," and interpreted to be a pathological lesion, but we regard it as a physical result when the intensity of Anti-Peristalsis exceeds the Ileocaecal tonicity.

The necessity for careful Colon study is indicated by our Statistics. One pathologic stomach or duodenum is found out of each ten that report for examination, while of the Colons examined one out of six shows pathology present.

ROENTGEN FINDINGS IN THE MORE COMMON PATHOLOGICAL LESIONS.

It is to be borne in mind that wide variations occur in size, position, outline and peristalsis in the normal stomach, and the beginner in Roentgenology is warned against making a positive diagnosis on evidence that is indirect or symptomatic. It is necessary to *show the lesion* in these doubtful cases, by patient and persistent work, and by re-examination, before a positive opinion can be given. Too often the Roentgenologist is encouraged to give a positive diagnosis, by the hasty surgeon or internist, before sufficient evidence has been collected, and so finds himself in an embarrassing position. Many plates are often required to clear up a doubtful case, and if you are still in doubt a negative opinion must be given.

The Esophagus.—

Diverticulum—

1. Usually occurs at first portion near pharyngeal junction.
2. A separate sac formation outside of regular Esophageal outline.

Cardio Spasm—

1. Obstruction of Cardiac Orifice.
2. Obstruction, cone-shaped with smooth regular outline.
3. No irregular filling defect.

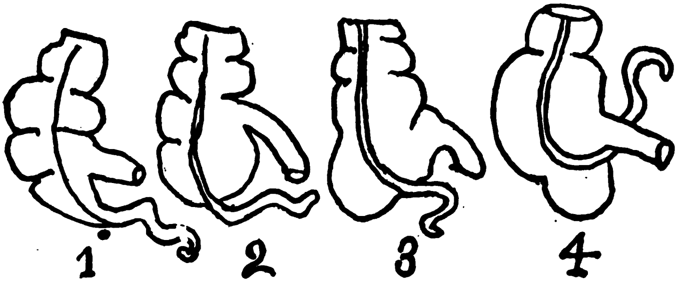
Carcinoma—

1. Obstruction or narrowing of lumen, usually near the Cardia.
2. Obstruction, irregular shaped.
3. Filling defect the rule.

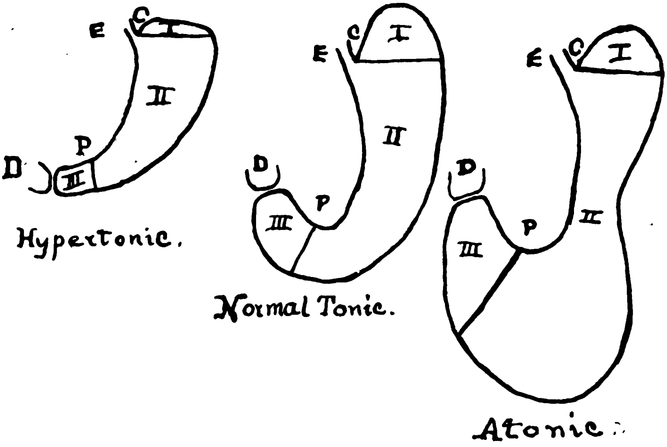
Cicatricial Strictures or external adhesions may cause obstruction similar to Cardio Spasm or Carcinoma. They are not so common, however, and can usually be differentiated by the above mentioned points. Tumors of other organs may cause distortion of the Esophagus by pressure.

Foreign bodies must be diagnosed and located.

TYPES OF NORMAL CÆCUM-TREVES.



TYPES OF NORMAL STOMACH.



I. CARDIAC PORTION II. BODY III PYLORIC PORTION

E. ESOPHAGUS C. CARDIAC INCISURA P. INCISURA ANGULARIS

D. DUODENUM

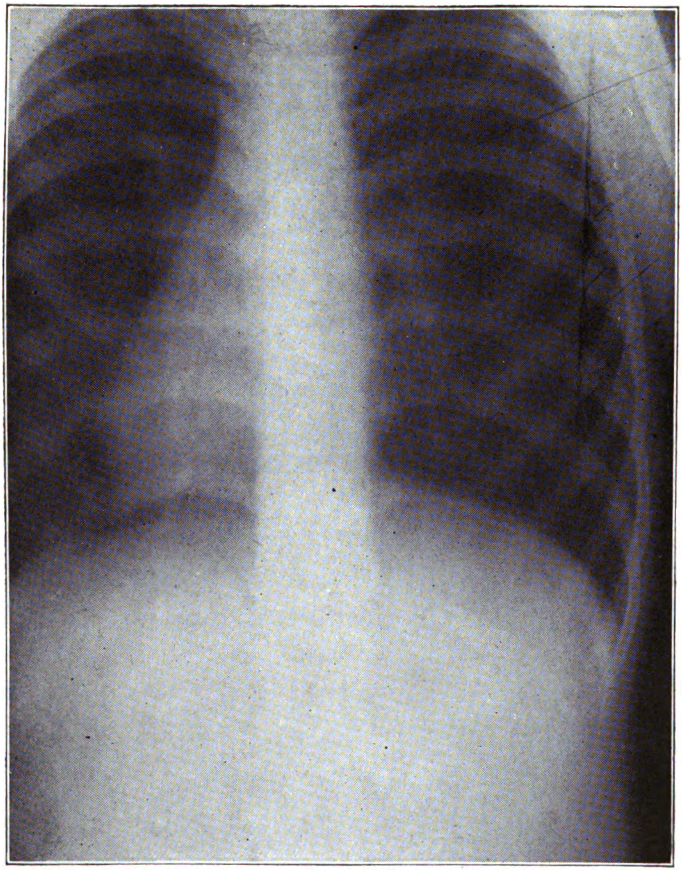


FIG. NO. 1.

Fig. No. 1. Boy, age 11, weight 49 lbs. Symptoms of asthma which were worse after eating. Chest examination for T. B. negative. Opaque meal was then given with result shown in Fig. 2.

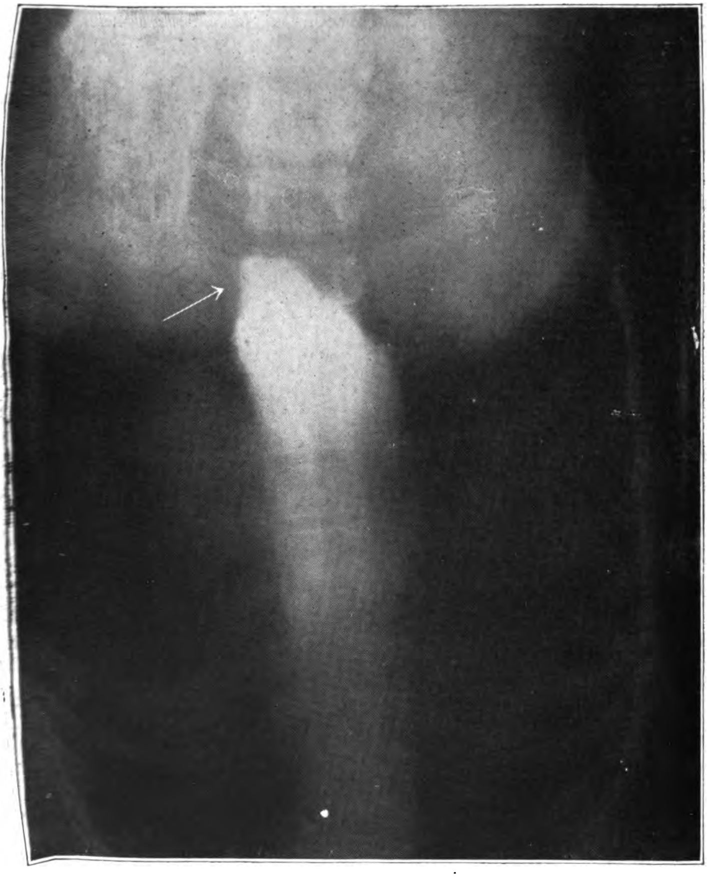


FIG. No. 2.

Fig. No. 2. Twenty minutes after the opaque meal the barium is held up as a column. Note the smooth cone-shaped constriction with a little barium trickling through. Absence of filling defect and irregularity rule out malignancy. Diagnosis—Cardio-spasm. Cured by dilatation.

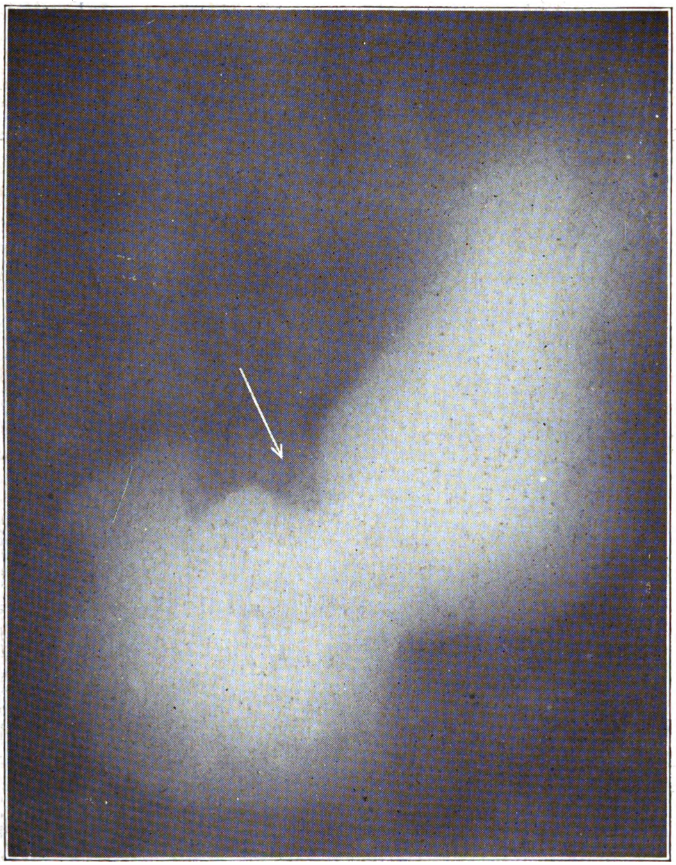


FIG. NO. 3.

Fig. No. 3. A woman, age 36. Atonic type of stomach. Small filling defect at indicator, with incisura opposite, approaching hour glass formation. Diagnosis—Ulcer of the lesser curvature confirmed by operation.

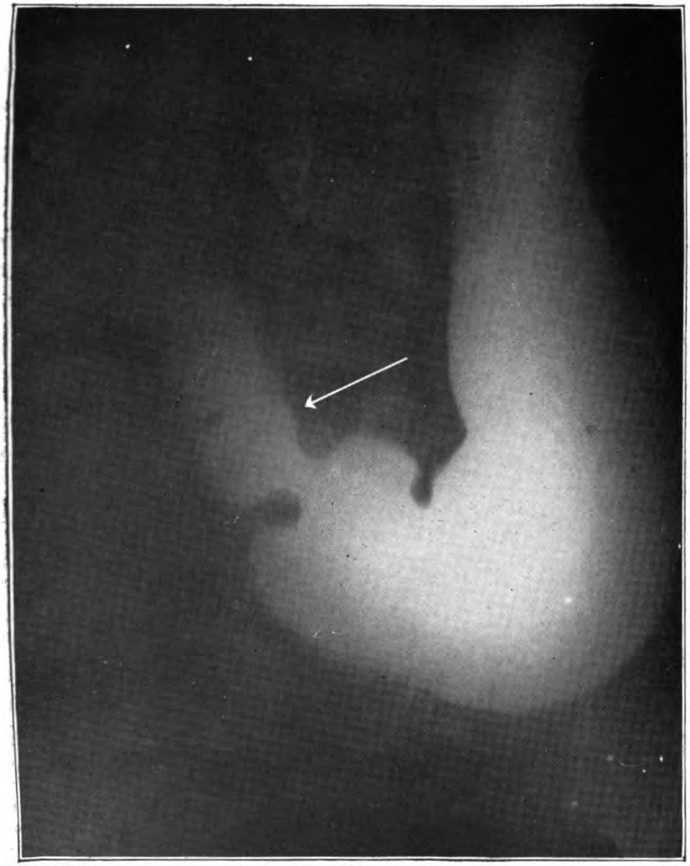


FIG. NO. 4.

Fig. No. 4. Normal tonic type of stomach. Filling defect in the bulb of the duodenum at indicator. Diagnosis—Duodenal ulcer, confirmed by operation.

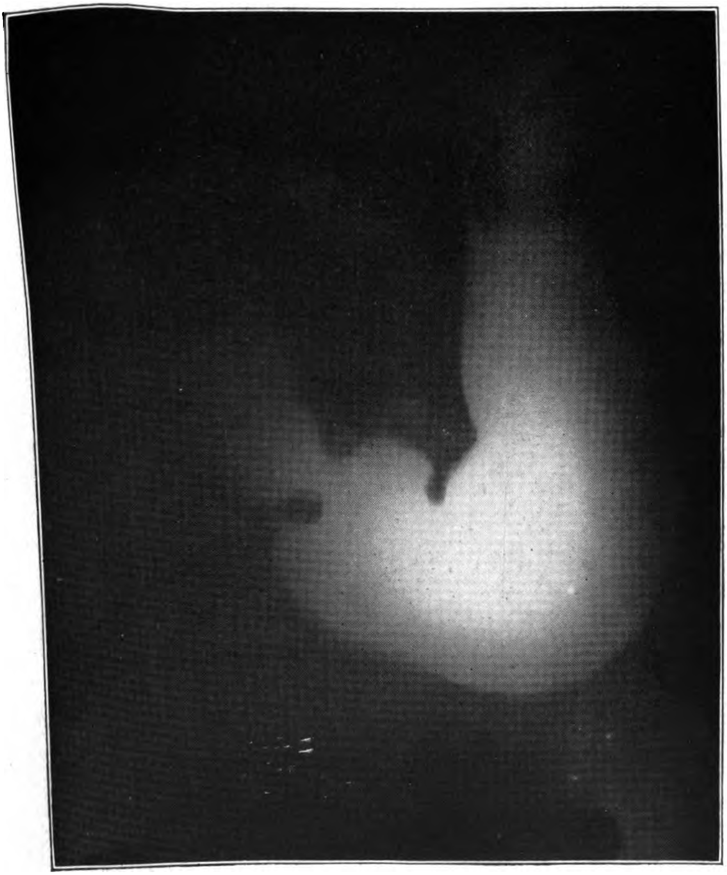


FIG. NO. 5.

Fig. No. 5. Normal stomach, showing the smooth lesser curvature, absence of incisura, smooth bulbus duodeni.

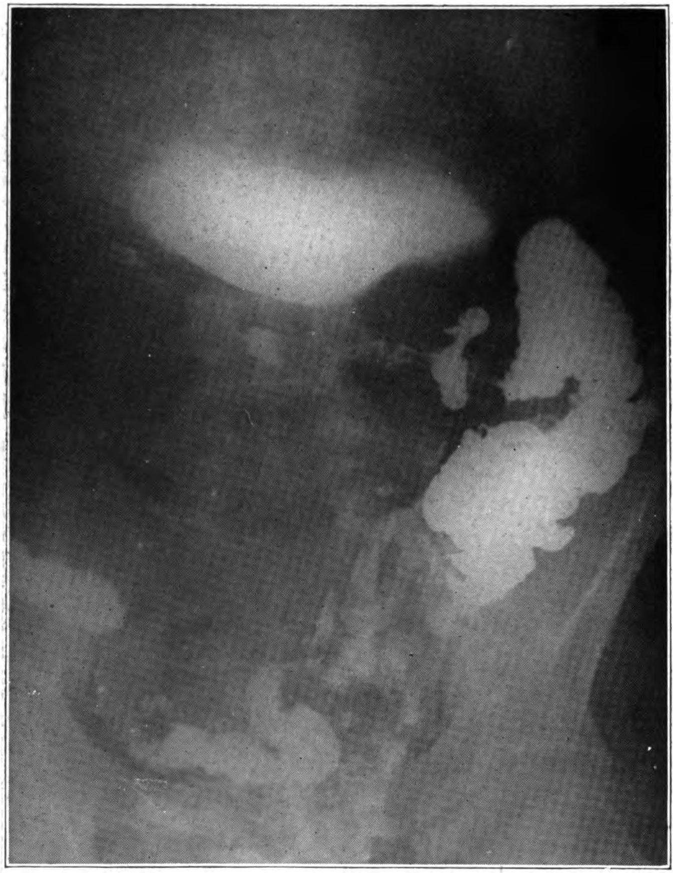


FIG. No. 6.

Fig. No. 6. A twenty-four hour plate, showing large barium rest in the stomach (third degree). Remainder of the meal is seen in the terminal ileum and colon.

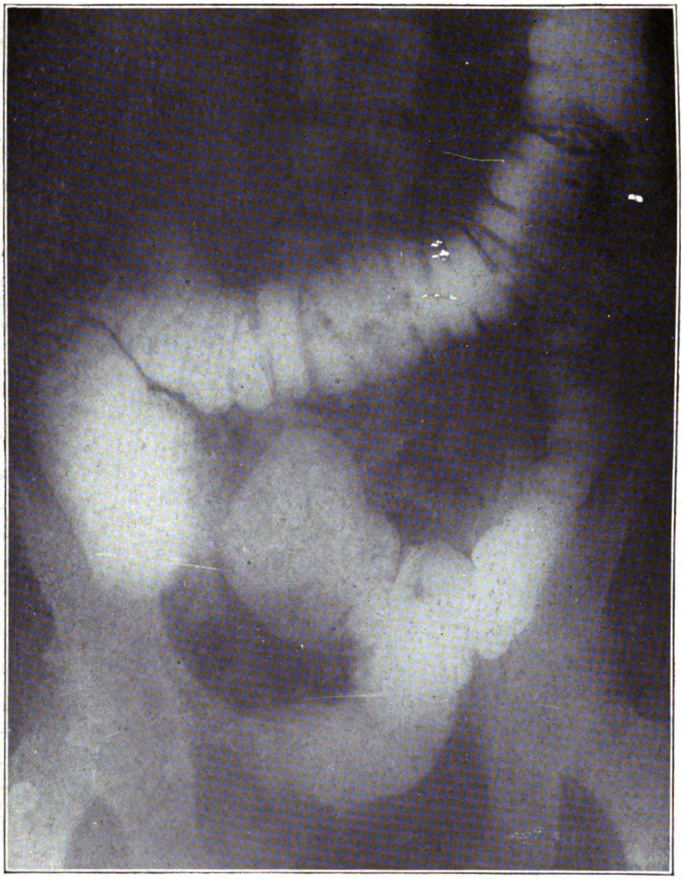


FIG. No. 7.

Fig. No. 7. A normal colon of the atonic type after the opaque enema. The loops of the sigmoid are large but considered normal.

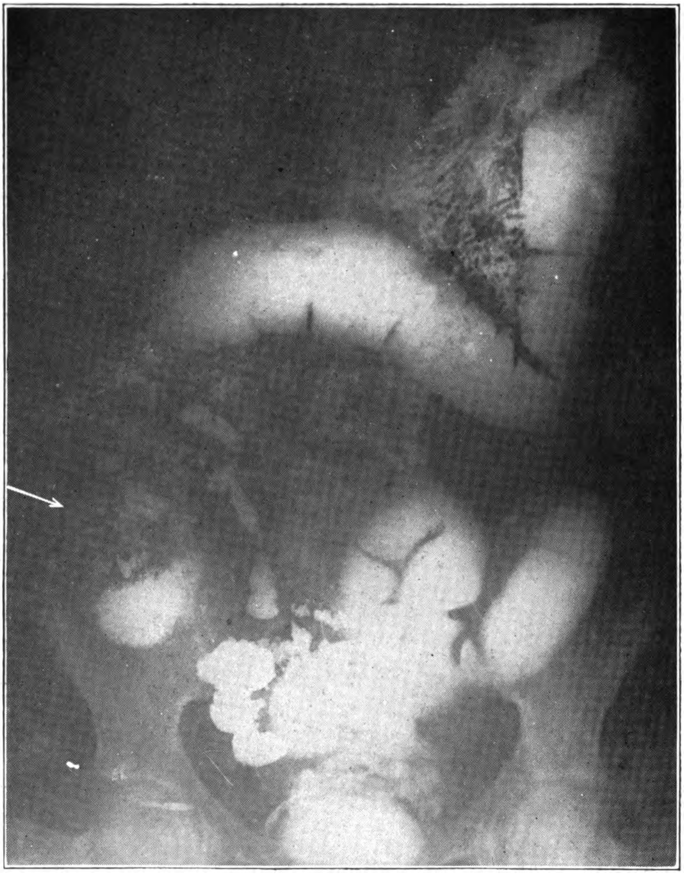


Fig. No. 8.

Fig. No. 8. Colon after opaque enema. Barium is seen in small balls and thread-like formation at indicator. Diagnosis—Mucous colitis.

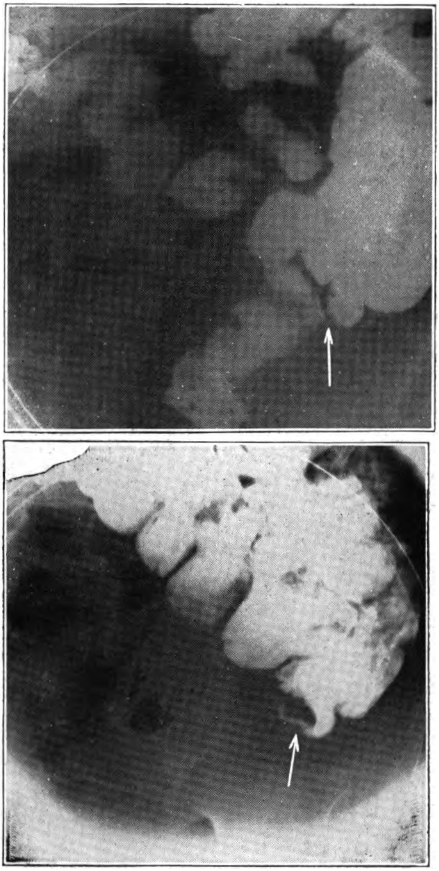


FIG. NO. 9.

Fig. No. 9. The cut above shows the terminal ileum adherent to the appendix at indicator, forming a typical Lane's kink. Eighteen hour observation. The cut below shows the same case at the twenty-four hour observation, when the terminal ileum has been completely emptied, giving a better view of the appendix at the indicator.

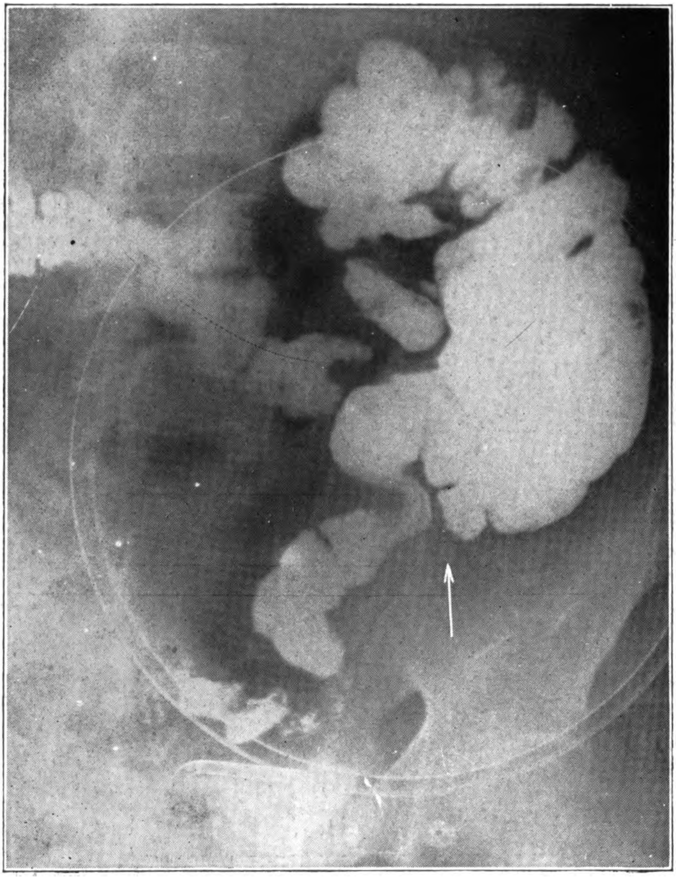


FIG. No. 10.

Fig. No. 10. A case very similar to Fig. No. 9, showing the ileum adherent to the appendix at the indicator with the characteristic kink formation. Eighteen hour observation, confirmed by operation.

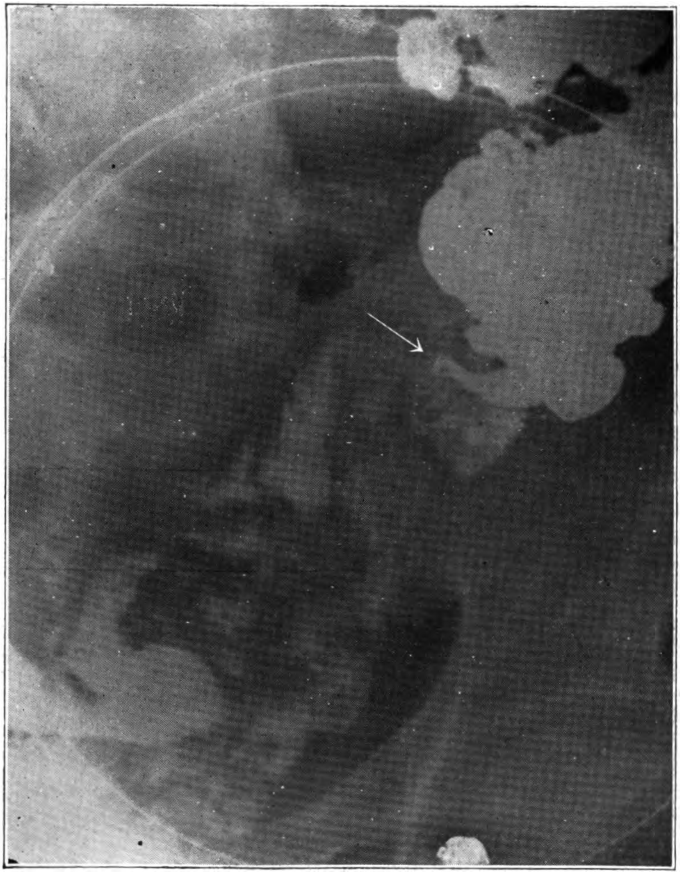


FIG. NO. 11.

Fig. No. 11. A typical case of chronic appendicitis with adhesions. Abnormal filling of the tip as well as fixation of the tip is shown at the indicator, confirmed by operation.

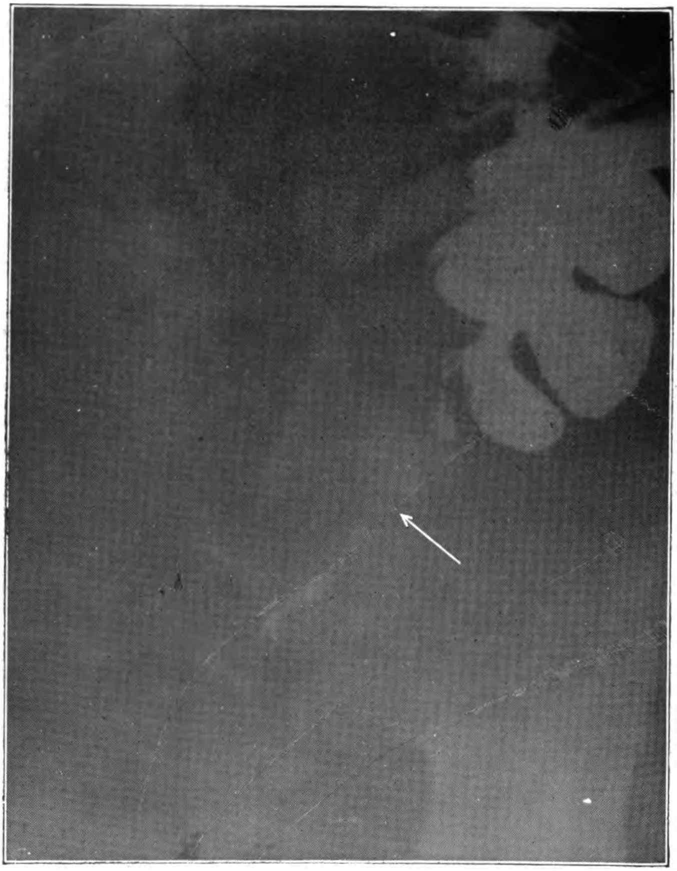


FIG. NO. 12.

Fig. No. 12. Chronic appendicitis with three fecal stones, causing a break in the outline of the appendix. The largest stone is located at the indicator. Confirmed by operation.

Gastric Ulcer.—

1. Shallow ulcers and erosions.
2. Callous ulcers with crater formation.
3. Perforating ulcers.

1. The first class cannot be positively diagnosed by X-ray evidence, as the ulceration is not sufficiently large or deep to hold the opaque substance and thus show a definite shadow. Their presence may be suspected by the finding of Incisura, Gastric Spasm, Hyperperistalsis, Barium rests and tender points.

2. The round callous ulcers most often occur on the lesser curvature. They are proven present when the Barium filled crater can be seen protruding out from the smooth gastric outline. They are often accompanied by a persistent incisura on the opposing wall. Lateral views are usually necessary to show their presence on the posterior wall.

3. Perforating ulcers give similar findings as Class 2, with the additional formation of a cavity outside of the stomach outline or the evidence of adhesions.

Evidences of Gastric Ulcers.—

Positive—
  1. Niche formation.
  2. Separate Cavity formation.

Uncertain—
  1. Incisura.
  2. Hour glass formation.
  3. Retention of opaque meal.
  4. Hyperperistalsis.
  5. Tender points.
  6. Irregularity of pyloric antrum.

Duodenal Ulcer.—Ulcers of the first portion of the Duodenum can usually be shown because of the fact that any filling defect or irregularity of its smooth cap or bulb-like formation can be clearly demonstrated. Fortunately most ulcers of the Duodenum occur in this portion.

The second and third portions have a serrated appearance produced by the Valvulae Conniventes. The Barium passes rapidly through these parts of the Duodenum, and ulcers are difficult to detect, except in cases of obstruction. The opaque meal can be temporarily arrested by firmly pressing the third portion against the spine, giving a better filling and a more certain outline.

Evidences of Duodenal Ulcer.—

Positive—

1. Filling defect in bulb.
2. Irregularity in bulb.

Uncertain—

1. Failure of the cap to fill.
2. Retention of opaque meal.
3. Fixation due to adhesions.
4. Tender points.
5. Hyperperistalsis with enlargement of stomach cavity.

Obstruction of Small Intestine.—Obstruction can be demonstrated in any part of the small intestine, and its location approximately fixed, especially if the obstruction be chronic or incomplete. Its cause can not usually be demonstrated.

The horizontal position is often required for the successful Roentgenoscopy of the Cardiac portion of the stomach and the duodenum.

COLON.

Ileal Stasis is considered to be present when the Terminal Ileum retains the barium more than eighteen hours.

Colon Stasis is present when any considerable part of the opaque meal is found present after forty-eight hours. There are two types of Colon that show stasis:

1. Atonic type, where the outline is smooth and wide and almost devoid of peristalsis. There is much evidence of gas present.
2. Hypertonic type, where the outline is narrow. There is much evidence of peristalsis and anti-peristalsis, and the barium is apt to be divided in small areas.

Ileocaecal Tuberculosis.—

1. Ileal stasis present.
2. Distortion of outline of terminal ileum.
3. Distortion, narrowing, or absence of normal Caecal outline.
4. Fixation of Ileocaecal region.

Chronic Appendicitis.—X-ray evidence is most reliable in chronic appendicitis. Observation should be made eighteen to twenty-four hours after the opaque meal.

Positive evidence—

1. Distortion of normal outline.
2. Failure of Appendix to fill.
3. Presence of concretions.
4. Fixation of Appendix to other structures.

Uncertain evidence—

1. Abnormal position.
2. Tender points.
3. Retention of barium.

The normal Appendix rhythmically fills with the barium and empties to fill again in a short time. If after repeated observations Appendix does not fill it is proof-positive that it is involved.

New Growth.—The most common locations are the

Ampula Recti, the Transverse Colon, the Sigmoid Loops and Descending Colon.

1. Permanent narrowing of the annular type.
2. Filling defect.
3. Obstruction to the opaque enema greater than the opaque meal.

Colitis.—Instead of smooth outline barium appears in balls or shreds.

Adhesions.—Are commonly encountered in any location, especially in the more movable parts of the Colon, Caecum, Transverse Colon, Loops of the Sigmoid. They are evidenced by:

1. Abnormal fixation.
2. Distortion of normal outline.

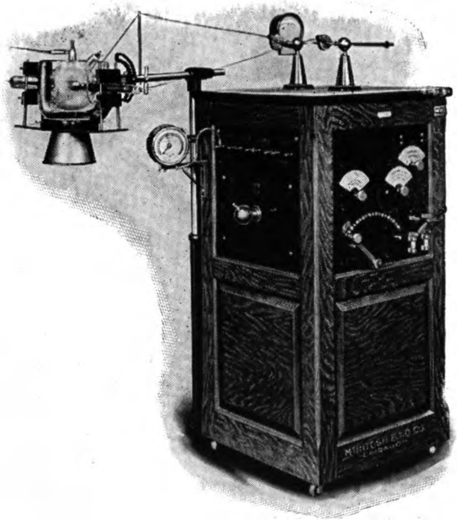
Diverticulitis.—Diverticula are most common in the Descending Colon or Sigmoid Loops. The separate pockets are usually visible after the passage of the opaque meal. A cleansing enema should be given before the examination, and the presence of the separate pockets confirmed by administration of the opaque enema.

Abdominal Relaxation.—

1. General (Glenard's manifestation). A symmetrical low position of the greater curvature of the Stomach, the Transverse Colon and the Colon Flexures is observed.
2. Local (Nephro-Coloptosis). The kidney, usually the right, with its corresponding Colonic Flexure, is shown to be in a low position, out of proportion to the position of the greater curvature of the Stomach and the remainder of the Colon.

Observation must be made in the vertical position.

The foregoing classification should be of great assistance to surgeons in determining which patients will be benefited by Nephropexy.



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CHAPTER XVI.

TREATMENT OF UTERINE FIBROIDS BY DEEP ROENTGEN THERAPY.

The two principal properties of the Roentgen rays are their ability to affect photographic paper and their power to restore diseased tissue.

Physicians in general are familiar with the former, or Roentgenology, but I believe that a much smaller number are acquainted with Roentgenotherapy, and especially deep Roentgenotherapy as it is being used today.

For some time the X-ray has been considered one of the best means employed for curing skin diseases, such as acne, eczema, parasitic skin diseases, lupus and epithelioma.

The same curative action of the rays has been conceded by many for tubercular glands and other diseased tissues where superficially situated.

Until recently, in fact, the benefits derived from the X-ray treatment of disease have been understood to be in direct proportion to the depth of the lesion.

How to reach the deeper tissues and accomplish for them what was being accomplished for the superficial has been the study of Roentgenologists from the time of the discovery of the X-ray.

Operators have reasoned thus, that if the X-rays had the power of destroying pathological tissues when situated in the skin and underlying structures, they would surely do the same for the deeper structures if only they could be made to penetrate them in sufficient dosage. The great drawback in reaching deep-seated tissues was that these rays must all pass through the skin. The latter absorbed the most of them and was often destroyed in the attempt to reach the deeper tissues, while the latter received a very small percentage of the rays.

It has only been in the last three years that much has been accomplished for pathological conditions involving deep-seated structures by the X-ray.

Previous to the year 1915 many attempts were made to reach the deeper tissues with the X-rays, but only occasionally were results at all satisfactory. Within the past three years so much has been done to develop the X-ray, both in the manner of applying it and also in the invention of new apparatus that we are now able to penetrate the tissues with X-rays of quantity and quality, thus enabling us to obtain positive results.

Cross firing and filtration first used in this country by Pfahler, of Philadelphia, and later elaborated by Kronig and Gauss, of Germany, have made it possible to give sufficient amounts of X-rays, for example, to fibroid tumors of the uterus, to completely remove them, and this without injuring the skin and intervening healthy tissues. By dividing the skin over the abdomen, in case of a fibroid tumor, into small areas and directing the rays through each one of these toward the growth, at the same time protecting all unexposed parts by lead or protection cloth, we are able to give the tumor many times more X-rays than formerly, when we depended upon a single area of skin for reaching the growth.

It will be readily seen that if the skin over the abdomen be divided into twelve parts and the rays directed toward the growth and passed through each one of these in turn, twelve times the amount of rays will pass to the tumor. This will be done without injuring the skin, for each area is given only as much as it will stand without burning. This method of treating deep tissues through small areas of skin is known as cross firing.

That some substances are capable of absorbing the softer rays, those which are the most injurious to the skin, is another discovery which has contributed in large measure to success in deep therapy. It has been determined that by passing the rays through aluminum, leather and other substances the skin will stand much larger doses of X-rays than when it is directly exposed to them.

The latter is known as filtration. By passing the rays through 3 or 4 mm. of aluminum a double skin dose may be given safely through each area. This, together with the fact that many fields are used as portals of entry, makes it possible to administer to the growth in question hundreds of times more X-rays than we were able formerly to give. Instead of 10 X Keinbock or 5 Holzknecht we can give 20 X or 10 H and this through as many areas as we may deem advisable, utilizing not only the skin of the abdomen, but also that of the back and gluteal region.

The technic as given by the Freiberg School of Germany was published in the fall of 1913, with report of 100% cures in suitable cases.

That same fall several Roentgenologists from America visited clinics in Berlin, Vienna, Munich, Heidelberg and Freiberg. After returning to America and employing the Freiberg technic they reported practically the same percentage of cures as reported in the 1913 report. Operations were performed only when X-ray therapy was contraindicated.

Kronig and Gauss consider all fibroids amenable to X-ray treatment, except, first, Pedunculated fibroids showing through the cervix; second, Cases in which gangrenous degeneration is suspected; third, Fibroids co-existent with carcinoma, or those having undergone sarcomatous degeneration; fourth, Fibroids which led to incarceration of the bladder. They do not allow for size of the fibroid, or age of the patient.

The object to be obtained is to produce a permanent amenorrhea, after which time the tumor gradually shrinks in size and becomes quite small or disappears altogether. Stern finds it very difficult to produce a complete and permanent amenorrhea in very young women. In a woman of thirty-two years he gave nine complete series. A fibroid reaching to the umbilicus is hardly palpable now.

He thinks it may not be best to produce a permanent amenorrhea in all cases, especially in younger women. He says, "In women under forty, unless an operation is contraindicated, or objected to, when a partial operation can be performed leaving menstruation possible, it is perhaps preferable to operate. When complete hysterectomy is necessary it is preferable to use X-ray.

He gave a case sufficient X-ray to reduce the size of the fibroid and cause temporary amenorrhea. The patient became pregnant later on. In the treatment of such cases he prefers the fractional or Alber-Schoenberg method.

Patients nearing the menopause are best adapted to this treatment. The Freiberg technic is as follows:

1. Divide the abdominal, dorsal and gluteal regions into small fields; twelve to the abdominal and six to the dorsal and gluteal.

2. Cross fire (that is, treat each one of these areas with a massive dose of X-rays. This means all that the skin will stand without burning).

3. Penetration. Take a tube which will back up a nine or ten inch spark gap or register 8 to 10 on the Bauer qualimeter.

4. Filtration. 3 to 4 mm. of aluminum and a layer of sole leather.

5. Massive doses. A maximum dose from 15 to 20 X through each field treated.

6. The number of series necessary in women above forty is from three to six.

7. No patient is considered cured until she is completely amenorrheic. One or two series should be given after this.

Stern succeeded in getting amenorrhea with diminution in size of the fibroid in every patient over forty years of age, in other words, 100%.

The average length of time necessary to produce amenorrhea was about six weeks. A number become amenorrheic in two series. The average number of series given were between four and five.

The nearer the climacteric the easier amenorrhea is produced. In patients under forty he succeeded in getting marked diminution of the fibroid with an amenorrhea which may or may not be permanent. The number of series was more in these cases.

He believes all uncomplicated cases are amenable to X-ray treatment.

In my cases the length of time required to cause the ovaries to cease to functionate and bring about a cessation of menstruation has depended almost entirely upon the age of the patient; the size of the tumors has made no perceptible difference. My patients have all been between the ages of 35 and 50, with the exception of one girl, aged 24, that I am now treating, but it is too soon to state results in this case.

Case 1. Mrs. M., aged 38 years; menstruated at the age of 11; married at 21; has no children; always had painful menstruation, with profuse flow. These symptoms were becoming much exaggerated when she came to me for examination, which was made, and a fibroid tumor revealed. She was given her first X-ray treatment March 10, 1916. Three series were given—cross firing through twelve areas. Dose 48 Hampson. The patient has not menstruated since July and shows no signs of it returning one and one-half years later.

Case 2. Mrs. C., aged 39; first menstruated at the age of 14, and was always regular; married at 26; no children. Present trouble began four years ago; menstruation caused much pain; flowing excessive. Examination revealed small fibroids with adhesions. Treatment with the Coolidge tube was begun February 5, 1917. Four series of 48 Hampson each were given between that time and June 5, 1917, when menstruation was completely abolished.

Case 3. Miss J. C., aged 41 years; always regular until March, 1916; began menstruating May 27, 1916, flowing almost constantly until August 3, 1916; no pain; pressure of tumor on the bladder caused frequent micturition. Examination disclosed a fibroid tumor, size of an orange. She was given two series of treatments, 48 Hampsons each, between August 3, 1916, and September 23, 1916, which was sufficient to bring about permanent menopause.

Case 4. Miss F., aged 40; has always had rather scant, painful periods. A year before taking treatment she began to have pressure, with somewhat increased but irregular menstrual periods. The diagnosis of fibroid tumor was made; three series of treatments were given between November 4, 1915, and January 22, 1916, when menstruation ceased and the tumor disappeared.

Case 5. Miss T., aged —; had a fibroid tumor size of a six months' pregnancy; menstruated every three weeks very profusely; had had pronounced pressure symptoms, and became very anemic; three series of treatments were given, when menstruation ceased and the tumor gradually decreased in size. When last seen the uterus was very nearly normal, and the patient's health greatly improved.

Case 6. Mrs. W., aged 49; married 30 years; four children; two miscarriages; normal labors; has never had good health; menstruated at 15, and always had severe pain and excessive flow. Four years ago had left ovary and tube and part of right ovary removed; inflammation of bladder; urinates very often; appetite poor; bowels constipated; general debility and anemia. Diagnosis, fibroid tumor size of an orange. One series of treatments were given, when the menopause was established.

Case 7. Miss F., aged 38; has been curetted six times for persistent flowing; no regularity of menstruation; the menopause was brought on by three series of treatments given between February 10, 1917, and May 23, 1917. The patient was much improved in health.

Case 8. Miss G., aged 49; menstruated first at the age of 14; about normal until ten or twelve years ago, when menstruation became profuse, lasting from ten to twelve days at a time; was curetted two years ago, and improved until recently. Diagnosis, interstitial fibroid in anterior wall, size of a grapefruit. One and one-half series of treatments resulted in establishing the menopause.

Case 9. Mrs. T., aged 46; married, but no children; has been menstruating irregular for about three years, her periods lasting from ten to twelve days; very profuse and many clots. Her physician made a diagnosis of fibromyoma, and referred her to me for X-ray treatment. Two series of treatments was necessary to bring about the menopause, the tumor decreasing in size, but it is too soon for it to have disappeared.

Case 10. Miss M., aged 42; first menstruated at 17; very profuse from the first; was irregular until about 22, when she took a course of gymnastics, after which menstruation was too often and too profuse; had curettage a year ago and has been much worse since, flowing nearly all the time for five months. Since the curettage has had more pain than before, it becoming necessary to give a narcotic several times. Four series of treatments were given between February 15 and September 1, when it was necessary for the patient to leave town. Six months later she called upon me and stated that she had menstruated regularly without pain, the flow lasting only three days. This exceptional case would undoubtedly have required one or possibly two more series of treatments to bring about the menopause.

INTERRUPTERLESS TRANSFORMER SUITABLE FOR DEEP ROENTGEN THERAPY.

As many of my readers have only the older modalities of current, such as the galvanic, faradic, sinusoidal, etc., I have deemed it best to add a chapter on the treatment of uterine fibroids by galvanism, which has proven as successful in my hands as any of the newer methods, and is devoid of the dangers of the X-ray.

CHAPTER XVII.

THE TREATMENT OF UTERINE FIBROIDS BY GALVANISM.

At the time Dr. Apostoli advocated the treatment of these neoplasms by galvanism, electro-therapy was in its infancy, consequently many of the adverse criticisms of his methods were the result of ignorance of the laws governing electrical energy. Many brilliant results were reported, however, which led to so much enthusiasm that every physician who bought an electrical outfit purchased it for the treatment of uterine fibroïds, only to find that it takes patience, skill and an accurate knowledge of the remedy. This state of affairs soon induced the better members of the profession to look upon the whole thing as a fad, and for some time back very little has been said of Dr. Apostoli's technique except to damn it.

Many students—pioneers in the use of the remedy—who had faith in the master, have continued their investigations, and, by various modifications of the original technique, their efforts, have been crowned by sufficient success to amply repay them for the labor.

In order to better understand the therapy of the writer's technique it must be borne in mind that the class of tumors to be considered are distinctly benign, and, while they may take on many forms of degeneracy—colloid, calcareous or even suppurative—he has never seen them assume a carcinomatous or otherwise malignant degeneration. This, of course, does not imply that a cancerous condition may not be co-existent with the fibroid.

The principal characteristic of all benign growths is that when their nourishment is interfered with they retrograde, and one of the strongest evidences of the benign character of uterine fibroma is the retrograde action they take on at the time of the menopause. A very popular operation—ligation of the ovarian and uterine arteries—was based upon the same principle, but while the vascularity of the tumor was reduced by this process, and its growth arrested, the blood supply to the uterus and ovaries was also interfered with, and a premature menopause brought on in women who had not passed the child-bearing period, for these growths are most apt to appear between the ages of 35 to 40 years.

The ultimate result sought for by the technique of Dr. Apostoli was the complete disintegration and absorption of the growth. This could only be attained by the alkaline caustic effects of the negative pole with a dosage of from 150 to 250 milliamperes, which was not within the limits of tolerance of most patients. Besides the use of such a current strength would necessarily set free much sloughing tissue within the pelvis, too much, in fact, for the absorbents to eliminate, and it was due to this fact chiefly that the original technique was so severely criticized and generally abandoned by the profession, who realized moreover that patients subjected to this treatment must have constant attention in a special hospital.

Realizing the benign character of these neoplasms and keeping in sight that any retrograde action set up in them depends upon an interference with their nutrition, the writer has adopted a technique directly opposed to that of Dr. Apostoli, and uses the *positive* pole.

To those who understand the polar action of galvanism it becomes apparent that no disintegration follows the use of this pole. On the other hand it hardens and shrinks tissue by coagulating the albuminoids of the blood, constricts the blood vessels by its action on the vaso-motor nerves, thus lessening the blood supply to the growth, and, by its sedative action, allays the pain. This, then, is only a symptomatic cure, and, for the past ten years, was all the writer has aimed to do—have the patient pass the balance of her life in comfort, or keep the growth in check until such time as nature will further care for it by taking the vascularity from the uterus and its appendages.

Strange as it may appear, it is not often necessary to enter the uterus in the treatment of uterine fibroma, principally for the following reason: The "point of indifference" is the point in the interpolar space where the *polar effect* of one pole begins and the other ends. This point is always removed towards the side of the greatest resistance, and, in the operation under consideration where the electrode on the abdomen is negative and the one within the pelvis positive it becomes apparent that the "point of indifference" is somewhere in the abdominal wall; the resistance being practically all on the negative side.

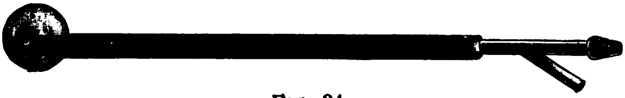

FIG. 34.

It is obvious, then, that if the positive electrode be placed well up in the posterior vault of the vagina, all the organs *between* the two electrodes will be subjected to the *polar* action of the *positive* pole—sedative, hemostatic, etc.

We can always promise to arrest the growth of the tumor, stop the bleeding and allay the pain, and, in some favorable cases, the writer has succeeded in bringing about almost entire obliteration of the tumor.

A suitable electrode, shown in the accompanying illustration (Fig. 34) is composed of a hollow metallic staff about

⅛ inch in diameter, insulated with hard rubber. To the distal end of this is attached a hollow copper ball one inch in diameter, which is perforated in a number of places to allow the escape of fluids. To the proximal end is soldered a receptacle for the cord tip. The electrode is about ten inches over all.

The ball is now covered with a medium layer of absorbent cotton, over which is placed a piece of gold beater skin* (see Fig. 35) and the whole fastened firmly by silk thread. With the aid of a uterine or other syringe with suitable nozzle, sufficient solution of suprarenal capsule is introduced through the hollow staff to saturate the cotton; then after the skin covering is well wetted upon the outside the instrument is ready for use.

FIG. 35.

After a large and well moistened pad is placed upon the abdomen and attached to the negative terminal, the vaginal electrode is attached to the positive and inserted well up into the cul de sac of Douglass. A current flow of from 60 to 80 milliamperes is maintained for ten minutes and the seance repeated three times per week.

When the uterine canal is not too tortuous the nourishment may be cut off from the growth much more rapidly by intrauterine application. Much inconvenience was caused formerly by this method and it was almost abandoned as impracticable because of the sticking of the electrode and consequent injury to the endometrium. This fault the writer has overcome by use of the instrument shown in Fig. 18, which is composed of hard rubber throughout, hollowed to receive the applicator. For 1½ inches and commencing ½ inch from the distal end, are bored a number of small holes through which electrical connection is made.

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*This can be purchased from dealers in surgical supplies in small squares, or in the form of what is usually called "skin condoms."

The applicator is a copper wire twisted upon itself and surmounted by a receptacle for the cord tip. After loosely winding absorbent cotton on the applicator the required distance, it is dipped into a solution of suprarenal capsule and replaced in the hard rubber receptacle.

By the aid of a speculum this is carefully introduced to the full depth of the uterus, and, having been attached to the positive terminal, a current flow up to fifty milliamperes is maintained for ten minutes and repeated twice weekly.

Both applications—vaginal and intrauterine—are highly antiseptic in character, first because the *polar* action of the *positive* is germicidal, and second because the oxychloride of copper which has been deeply deposited by cataphoric action, gives it eight times the microbicidal power of the positive pole.

About sixty per cent of all fibroids are interstitial. These do not grow in whorls or from nuclei as do the submucous or intramural varieties, consequently are the most amenable to electrical treatment.

Subperitoneal tumors are excluded from this category. They should be removed surgically.

After the growth has assumed a colloid or cystic degeneration it cannot be successfully treated by the methods herein described.

Adhesions do not contraindicate electrical treatment, in fact, the very cases that are inoperable on account of adhesions oftentimes symptomatically yield the quickest.

CHAPTER XVIII.

ELECTRICAL TREATMENT OF THE PROSTATIC URETHRA.

There is probably no class of disease so serious in its nature and so difficult to treat owing to its many complications, as affections of the prostate. The site of the lesion and anatomical structure of the urethra, the sensitiveness and delicate functions of adjacent tissue all combine to render any operation on these parts extremely difficult. It seems that the Lord in His goodness was endeavoring to equalize the suffering of the sexes when He made women without a prostate. The writer does not deem it advisable at this time to discuss either the etiology or pathology of the various phases of prostatic disease mentioned in this chapter, because there is no lesion in which the pathology is better known than in the affection above noted.

The reporting of immature results and deductions has always been the bane of current medical literature and the most that has been said regarding the disease in question is probably no exception to the above statement, because the promises of cure or relief from most of the methods in vogue have not been fulfilled.

As the scope of this chapter will have to do with prostatic hypertrophy as well as the irritable condition preceding it, the writer believes it would be well at this point to state his views regarding the pathology of the former disease, because they differ somewhat from those laid down in the text-books upon this subject.

The term *hypertrophy* used in this connection is rather a misnomer. True hypertrophy is only an enlargement of the normal cells composing the gland, but in the case in question, however, we have not a true hypertrophy, but rather an accumulation of tissue due to an inflammatory process, which comes up between the glandular elements and by pressure *reduces* them in size. The more proper term then would be *enlargement* of the prostate.

If, as has been stated by other writers, this were a true hypertrophy, then any means tending to actually destroy tissue would be irrational because such procedure would not decrease the size of the glandular elements but destroy them. The prostate gland is a sexual organ and the effect of any interference with its function is apparent to only a casual observer.

The actual cautery as employed by my friend, Dr. Robert Newman, of New York, seems irrational, because, contrary to the statement of the doctor, the writer believes it impossible to sear any mucous surface with a red hot instrument without producing the worst kind of cicatricial tissue. This tissue not only impairs the function of the prostate by interference with the excretion of prostatic fluid, but more often causes serious sexual disturbance by partially or wholly occluding the mouths of the ejaculatory ducts.

If, as Dr. Newman says, the galvano-cautery does not necessarily burn or destroy and is not followed by cicatricial tissue, then the writer believes that his operation is not different than an application from the negative pole of a galvanic battery, and the word *galvano-caustic* should have been used in the place of *galvano-cautery*.

It seems hardly necessary to go into detail here regarding Botinni's rapid method further than to say that the author of the operation does not deny that it *does* burn. It does not, however, reduce the size of the gland, but only divides it and while the writer does not deny that the patient may be able to pass all his urine in a short time, the scar tissue left by this burn not only impairs the function of the gland itself, but is eventually followed by a worse condition than simple enlargement; besides this, the operation is not dangerless, one case operated on at the Post-Graduate Hospital dying the next day from shock. Of the patients at St. Luke's Hospital that were operated upon by Botinni's rapid method the report for 1901 shows 33⅓% recovered, 55 5-9% temporarily improved and 11 1-9% died. Dr. H. H. Young, of Johns Hopkins, in speaking of this method says that some of the causes of death are uremia shock, sepsis, etc., brought about by the cautery blade burning its way into the rectum and making the incisions too long, resulting in the rupture of the urethra in front of the prostate, and sometimes fatal hemorrhage from division of perineal vessels.

If the condition *preceding* prostatic hypertrophy were properly treated much of the after trouble would be avoided and the object of this paper is more for the purpose of establishing a more rational treatment for the pathological conditions preceding than the hypertrophy itself. Chronic posterior urethritis, prostatorrhea, hypersensitiveness of the urethra and prostatic stricture are the more important lesions which eventually lead to so-called prostatic hypertrophy.

To allay any inflammation requires the application of the positive pole of the galvanic current, but whenever a metal electrode attached to this pole is applied to a mucous surface it always sticks firmly, due no doubt to the dehydrating properties of this pole. As it would be inadvisable to make such an application to the prostatic urethra, thereby disarranging the delicate mucous membrane, some means must be adopted to overcome this difficulty.

Some years ago the writer devised an electrode which largely overcame the existing difficulties and which was described in an article written at that time.*

As this electrode is fully described and the technique given in detail in the latter part of this chapter, under the caption of "Hypersensitive Urethra," we may now consider the treatment of those cases of so-called prostatic hypertrophy where the irritation has subsided and which are ready to treat for the *reduction of the gland.*

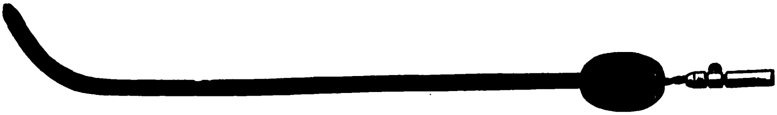

Fig. 18

The electrode here shown and found by the writer well adapted for the purpose, consists of a hard rubber tube closed at the distal end by a plug of the same substance and bent to a proper urethral curve. Small holes are now drilled in the tube for a space of two inches from the distal end. The applicator consists of a twisted copper wire to the proximal end of which is soldered a socket for the reception of the cord tip.

Absorbent cotton is evenly wound on the applicator for a distance of about two inches and after being dipped into a solution of potass. iod. (grs. xx to ℥i) is replaced in the hard rubber receptacle. The electrode is now introduced into the prostatic urethra attached to the *negative* pole of a galvanic battery, the positive being placed upon the abdomen and the current gradually turned on until a flow of ten milliamperes is reached, which may be maintained for ten minutes.

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*"The treatment of senile hypertrophy by cataphoric applications of iodin."

The purpose of this part of the treatment is to utilize the softening, disintegrating and liquefying effect of the *negative* pole and also to deposit the iodin from the solution into the gland.*

In treating an enlarged prostate it must be remembered that a loss of tone of the detrusor muscle of the bladder has much to do with aggravating the trouble. The office of this muscle is to raise the posterior portion of the bladder to a level of the prostatic urethra so that *all* the urine may be voided. Now, when the prostate is enlarged the floor of the urethra is higher than normal and the detrusor muscle fails to do its work, allowing the back part of the bladder to sag and accumulate residual urine. This, in turn results in ammoniacal decomposition, causing much inconvenience and suffering, so that the measure of success in these cases depends as much on restoring the tone of the detrusor as in treating the enlargement.

To accomplish this, we leave the electrode in place after giving the treatment as outlined above, turn on a slowly interrupted faradic current and continue the treatment for five minutes longer. This massage not only gives tone to the detrusor but stimulates the absorbents to take up the products of decomposition set free by the first part of the operation.

The results obtained from this treatment in several cases were given in a former article on this subject, since which time the writer has treated many cases by the methods described herein, and finds the results in original cases all that could be desired, but the complete failures or those only

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*In decomposing electrically a solution of potass. iod. it must be noted that the iodin is electro-negative and therefore has an affinity for the *positive* pole.

partially relieved were cases that had been operated upon either by the cautery or knife.

The cases showing the most marked results are those of simple enlargement in old men that are not complicated with inflammation. One case to illustrate being that of a man 66 years of age whose prostate was very much enlarged, who had not voided his urine without the aid of a catheter for more than a year. The introduction of the instrument, however, did not cause the least pain. He was given fifteen treatments with the negative pole and potass. iod., at which time he was able to pass his urine voluntarily, leaving a residual amount of about two drams.*

HYPERSENSITIVE URETHRA.

This unfortunate condition, which is one of the sequelæ of prostatic disease and gonorrheal infection, is more far-reaching in its deleterious effects upon sexuality than is generally imagined. It is one of the great causes of psychological impotence.

The electrode for the treatment of these cases is somewhat similar to the one shown in Fig. 18, the difference being that the holes are drilled to the *full extent* of the instrument. Absorbent cotton is loosely wound on the applicator its entire length and is well wetted with a normal salt solution. After being replaced in the hard rubber sound it is attached to the positive pole of a galvanic current and introduced to the full depth of the urethra. The negative is a pad upon the abdomen. A current strength of ten milliamperes is maintained for ten minutes, and the seance repeated not oftener than once in four days.

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* For additional treatment of prostatic hypertrophy see Chap. XIX.

CHAPTER XIX.

A NEW METHOD OF TREATING PROSTATIC DISEASES.

DuBois Raymond, in his experiments, observed that "heat coagulates the muscular plasma and brings about an *acid* condition;" also "a muscle that is fatigued assumes an *acid* condition." Schiff makes the observation that "veratria renders the muscle rigid, unirritable and *acid.*"

We know today that the anode of a continuous current attracts oxygen from the body fluids. Oxygen is an acid maker. Therefore, the part in connection with the anode is rendered *acid.*

What is the significance of this acid condition of tissue?

SIGNIFICANCE OF AN ACID CONDITION OF THE TISSUES.

It may not be new to you, because it was discovered as far back as 1859, by Funke and other observers, that the beginning of the death of any tissue, nerve or muscle is marked by a progressive acidity and subsequent coagulation of the muscular plasma. I have used the phrase "the beginning of the death," but I do not mean that the tissue is going to die. I only use the phrase to express a certain condition—an underactive condition.

It is also a well-known fact, first observed by Schiff, that all overactive conditions are alkaline, and that inflammatory lesions are due to excessive alkalinity of the part. Did you ever stop to think that your patient could not have pain with an acid condition, that it is impossible, that an acid condition is absolutely against pain? Do not bring up the question of rheumatism, which we have been treating upon a wrong pathologic conception for a hundred years, since the deposit in articular rheumatism is not uric acid but urate of sodium, and sodium urate is not an acid, but an alkali. And the same thing that causes pain in rheumatism causes it anywhere else in the body—alkalinity.

Since the appearance of the sixteenth edition of this work I have devised an electrode for the application of heat and galvanism to the prostate gland, the seminal vesicles and the female pelvic organs, which I shall describe, giving the technique of its application.

There seems to be no doubt in the minds of thinking physicians but that prostatic disturbances and their sequelæ are the most serious lesions for which they treat men. The symptoms are often so varied and diverse as to mislead any but the astutest diagnostician, who, not finding the gland hypertrophied, is likely to look for the trouble elsewhere.

While my former method of treating the prostate—as given in Chapter XVIII and on pages 219 and 220—has been productive of much good and brought favorable comment from many physicians, it is by no means ideal.

The method I am about to mention here, however, is much superior in many respects and does not necessitate entering the urethra.

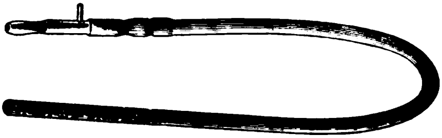
If you were called upon to treat an irritable gland that was accessible and in plain sight, the first remedy you most likely would think of would be heat. If you understood something of the therapeutic properties of electricity you would undoubtedly combine this heat with positive galvanism; the heat, because, as previously stated, it coagulates the muscular plasma and brings about an acid condition, which means an underactive or sedative condition;

the positive galvanism because it also begets an acid condition and relieves congestion by constricting the blood vessels.

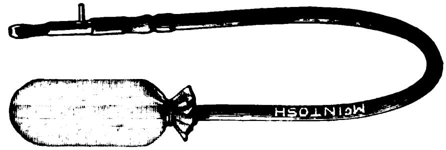
When the prostate is the gland involved, the seat of operation is not very accessible nor in sight; therefore, if we would employ these two valuable therapeutic aids, we must devise some special means for their application.

A two-pronged fork is a simple instrument, yet it has taken a thousand years to develop it; and although it might seem a simple matter to apply heat and positive galvanism to the prostate gland, it is not so easy to accomplish as it seems. First, because the applicator must be kept at an even temperature; and, second, the metal comprising the conducting portion of the electrode must not come in contact with the mucous surface being treated.

The electrode I have devised, and which answers the purpose admirably, is shown in the accompanying illustration. It may be described as follows:



No. 1. Showing Electrode Uncovered.



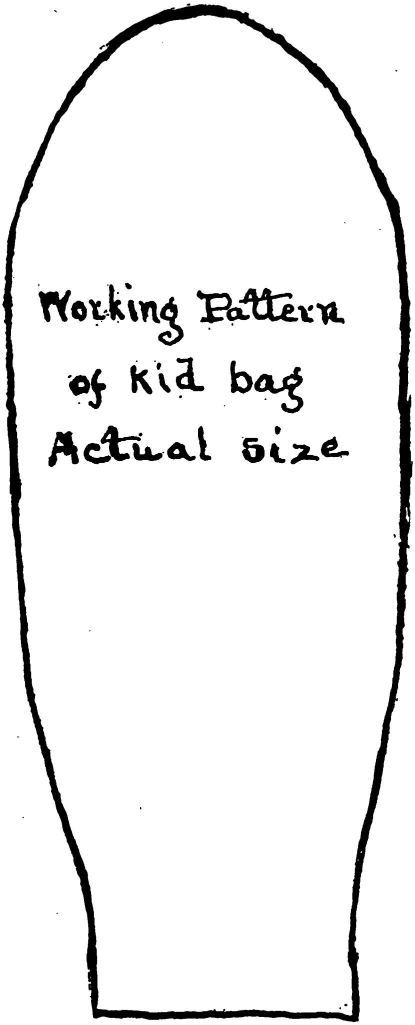
No. 2. Showing Electrode with Kid Bag Attached Filled with Water.

A soft rubber rectal tube about 15 inches long and having a caliber of 32F. has the distal end perforated with small holes for a distance of 2¾ inches.

The tube is fitted its entire length with a spiral wire composed of galvanized iron. To the proximal end of this spiral wire is permanently attached a metal fitting for the tube of any ordinary fountain syringe, and to this is soldered a receptacle for the conducting cord from the battery. To the perforated end of the tube an ordinary gold beater skin condom is firmly tied so as to include all of the perforations within the skin bag.*

The fountain syringe containing about one quart of normal salt solution at a temperature of 125° F. is placed at an elevation of about six feet.

Place the patient in Sims' position, with



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* The author now uses a bag made of kid, which is more durable and answers the purpose admirably.

the usual wetted pad on the abdomen attached to the cathode of a continuous current. After having thoroughly wet the skin bag, inside and out, force out all the water through the perforations, lubricate well and introduce into the rectum to cover the prostate. Slip the rubber tube from the syringe over the end of the electrode and allow the hot water to run until the bag is filled. Now fasten the tip from the anode of the battery into the receptacle on the electrode and turn on current until 30 to 40 ma. is reached. Continue the sitting for ten minutes and repeat three or four times a week.

Many complaints have come from those who have tried to use the electrode on account of the kid bag leaking. There are two ways to prevent this: first, cut out the kid after the pattern shown herewith, and have it sewed at a glove factory. This glove stitch is very close and will not leak under ordinary pressure. Second, never allow the bag to fill to its full capacity; if you do it will surely leak, and besides will not cover the gland properly. Always allow the water to flow into the bag about seven seconds before cutting it off, that will generally make it three-quarters full.

A few cases from actual practice will serve to illustrate:

Case I. Mr. M. B. J., aged 82, dairy farmer; veteran of the civil war; had never missed a day's work from sickness until six months before coming for treatment, when he gave up business altogether. Upon examination I found the prostate gland symmetrically enlarged to the size of a small orange. Two strictures in the pendulous urethra had been treated by gradual dilatation until he had an infected bladder. He was obliged to urinate from seven to ten times during the night. I treated the cystitis with hot boric acid irrigations and reduced the strictures by electrolysis, at the same time using the heat and positive galvanism to the prostate, as has been previously described. He improved very rapidly and was provisionally discharged in five weeks. He writes later that he is entirely relieved and has resumed business.

Case II. Mr. B. J., aged 79; attorney; general health fair; micturition very frequent; bowels very constipated; no other complications except extreme nervousness. I applied heat and positive galvanism to the gland for ten minutes four times per week, using 40 ma. Gland of normal size and consistence, with subsidence of all other symptoms, after two months' treatment.

Case III. J. A., physician; aged 45; chronic inflammation of the seminal vesicles, with partial impotence for several years; no sexual desire; prostate gland not much enlarged, but sore and irritable. I administered three treatments per week of heat and galvanism, resulting in complete cessation of all symptoms in two months.

Case IV. Mr. A. K., aged 40; politician; decidedly neurotic; said he had been treated for stricture for nearly two years and was still taking treatment, but was much discouraged; had a colorless discharge which the advertising doctor told him was semen and that his "life blood" was ebbing away. Upon examination I found the discharge to contain no spermatozoa, but was simply prostatic fluid. The prostate gland was somewhat enlarged and very irritable; urethra very hypersensitive; prostatorrhea. As a No. 32F could easily pass, I concluded there was no stricture. I treated him with heat and positive galvanism four times per week, using a weak solution of cupric sulphate in place of the normal salt solution. He was entirely relieved in five weeks.

There are several points that may be emphasized regarding the treatment, namely: The solution used in the skin bag may contain any desired medicament to be used cataphorically. The treatments are easily administered if you are prepared to give them. They are of greatest value in treating an irritable retroverted uterus. Enuresis yields quickly to them. They are indicated in any lesion dependent upon an irritable rectum.

CHAPTER XX.

TREATMENT OF VARICOCELE.

After the extensive experiments of Du Bois Raymond, D'Arsonval, Duchenne and other eminent observers, no one doubts the fact that currents of electricity traverse the body in every direction; that the nerves are the carriers of these currents, etc. If the nerves carry electrical currents they have poles, and consequently, *polar effects*. Where we have a positive nerve ending we have *positive* polar effects—acidity and an underactive condition. Where the nerve ending is negative we have *negative* polar effects—alkalinity and an overactive condition.

Every battery, by overwork, is subject to what we call "polarization"—a reversal of the direction of the current. Is it a very violent supposition to say that, by disobeying some of Nature's laws we have produced this very condition within our bodies and, where it was intended that a *positive* polar effect should be present we have now the very opposite condition.

A correct knowledge of polar effects is the keynote of the application of galvanism because these poles have diametrically opposite effects. There is always indication for the use of one or the other pole, and when one is indicated, the other will certainly aggravate the trouble.

Negative or disastrous results in the use of electricity can generally be traced to a lack of knowledge of these facts.

The most definite and known effect of galvanism is its action on the vasomotor nerves. The principal office of these nerves is to supply force to the involuntary muscles, and taking for our illustration of these muscles, the circular bands composing the walls of the arteries and veins, we can readily see how the blood supply and nutrition to certain parts may be influenced by an application of one or the other pole.

The positive pole acts as a powerful vaso-constrictor, lessening the lumen of the vessels and thereby causing a decreased blood supply to the part. On the other hand, the negative pole is just as powerful a vaso-dilator, rendering the walls of the vessels more patulous and increasing their caliber.

In varicocele we have an engorgement of the scrotal blood vessels, because the walls have become patulous from vasomotor disturbance, and cannot contract and expel their engorged contents. In other words, the part is in a negative condition, and it becomes evident that the positive pole must be used for the active one. What has proven a very successful technique is as follows:

The unipolar, divided current electrode designed by the writer for the treatment of varicocele, is shown in the accompanying illustration.

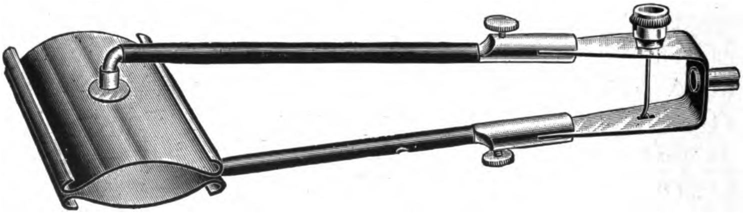


FIG. 10.

The proximal end or fork is of spring brass, to which is attached a receptacle for the cord tip. This end has also an adjustable screw, by the aid of which the operator can make firm contact upon any tissue included between the two small plates at the distal ends. These plates, which are semi-cylindrical in shape, and 1½ by 2½ centimeters in size, are made of pure tin in order to withstand the corrosive action of the positive pole. The entire length of electrode is 1.2 decimeters. A piece of absorbent cotton, well wetted, is placed upon each of the metal plates and the electrode applied to the upper part of the scrotum in such a way as to include the mass of enlarged veins between the two plates. The electrode is now attached to the positive pole of a galvanic battery, the negative being a large electrode upon the abdomen or lumbar spine.

The treatments are now given for ten minutes with a current strength of ten milliamperes, and the applications may be made daily, if the irritation of the skin of the scrotum (which necessarily takes place) will permit.

The pains, which are the most distressing feature, commence to be relieved after the second treatment, and generally cease entirely about the sixth. The veins decrease in size as their proper tone is restored, and unless the case is a very aggravated one, fifteen to twenty sittings suffice to effect a complete cure.

The positive being the active pole used has suggested the idea of placing upon it some medicament that might be utilized cataphorically to hasten the reduction in the size of the scrotal veins. This has been accomplished by wetting the cotton with Merrell's normal tincture of thuja, which being a very powerful vaso-constrictor greatly lessens the time of treatment.

CHAPTER XXI.

ELECTRICAL TREATMENT OF DEAFNESS.

"The shoemaker should not judge above the last," but I am induced to incorporate this short chapter on a very common but distressing lesion with no apology to the aurist, believing it may help him as well as physicians generally.

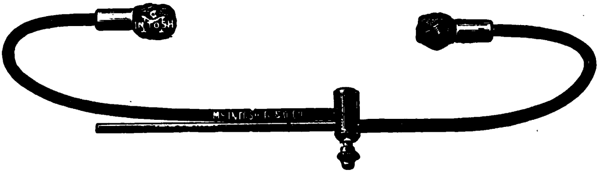
Case I. A young woman—school teacher—who desired to enter the normal school, failed to pass her physical examination on account of defect of hearing. She consulted me, but I told her I did not treat the ear, and sent her to a first class aurist. In about one month she returned, stating that the other doctor had done her no good, and she wanted electrical treatment.

I then consulted the aurist who had treated her, and asked him what the conditions were in the case. With a broad smile he said, "With a few exceptions all these cases of deafness are alike. The patient has a cold in the head, the inflammation extends by way of the Eustachian tube into the middle ear; the ossicles are inflamed, an exudate is thrown out around them which impairs their freedom of vibration, with consequent dullness of hearing. In time this exudate shrinks and hardens, with consequent further loss of hearing, until finally complete anchylosis takes place and the patient is deaf."

As this patient was determined to have electrical treatment, it did not take much study on my part, after what the aurist told me, to select the modality best suited for the case—the Morton Wave Current.

An electrode was then devised and is shown in the accompanying illustration:

It is needless to say that the current to be used is gotten from the static machine and the technic employed is as follows:



The Leyden jars should be *attached,* and for treatment as delicate as this the jars should be small. The ordinary jars, however, will answer, but more care is required in their use. If there is a switch pointer on the machine it must be placed upon "spark" which will connect the outer coatings of the jars, otherwise the outer coatings may be connected by a metal rod or chain.

Absorbent cotton is now twisted on the distal ends of the electrode and *pointed* so as to enter the aural canal. The cotton is wetted and the electrode placed in position on the patient, who sits on an insulated platform. The electrode is then connected to the top of one of the jars by a suitable conductor. The top of the other jar is "grounded" by connection with the water pipe. The machine is now started with the balls on the prime conductors *actually touching,* and after the machine starts to generate the balls are carefully separated until the limit of tolerance of the patient is reached. This rarely exceeds ½ inch, but generally ¼ inch is all the patient will stand. The seance is continued for ten minutes and should be repeated daily.

The patient was discharged after one month of treatment as above, the hearing being absolutely normal.

Case II. In May, 1916, Mr. F., farmer, presented himself for treatment, giving a history of increasing deafness for the past three years, until, at the present time he had not heard his wife's voice for four months.

He was treated daily for five weeks, as herein described, when he could hear the tick of a watch at 12 inches. He has since had no relapse.

Case III. Mrs. D., housewife, first noticed that she was getting "hard of hearing" about seven years ago. She could hear very little of ordinary conversation, and had given up using the telephone. I tested her hearing at different periods during her treatment, but could perceive actually no improvement, and despaired of doing her any good, until finally, after five weeks, she said to me, "Well, doctor, I will not be back for any more treatment because I hear as well as I did ten years ago, and can hear perfectly on the 'phone. I have been improving right along, but would not tell you, because I was afraid it would return." I tested her hearing and was surprised to note that she could hear the watch tick perfectly at a distance of 42 inches.

Cast IV. This case is quoted on account of its great chronicity, and the final results gained from treatment. Miss H., aged 50, had been engaged in missionary work in China for twenty years. During the last ten years she had gradually lost her hearing and became almost totally deaf. She was then forced to give up her missionary work and return to this country, when she fell into my hands. I gave her daily treatments, as has been described above, for seven weeks, when her hearing was so entirely normal that she returned to China to take up her missionary duties.

The routine treatment for these cases has always been massage, gotten by use of suction pump. This massage is purely passive and is very similar to that practised by the ordinary operator who uses the hand for manipulating the muscles. The massage given by the Morton Wave Current as described in this article is entirely different, and not only acts upon the muscles, but upon the nerves as well. Every time a spark passes between the prime conductors of a static machine oscillations are set up from a few to many million per second. These oscillations, or vibrations, are conveyed to the nerves, which, in these cases, have lost their normal vibratory tone, but will again be restored to their normal rate by taking the vibration which suits them from this current.

CHAPTER XXII.

GERMICIDAL PROPERTIES OF ELECTRICITY.

Many observations have been made to prove or disprove the assertion that electricity possesses bactericidal properties, and while most of the reports of these observers are true from their viewpoint, they are in fact entirely different when viewed from the standpoint of the electro-therapeutist.

Pathogenic germs, with, we believe, one exception, thrive and multiply in an alkaline or neutral medium, but whenever that medium becomes acid their growth is inhibited and death results, in fact it is well known that bacteria are destroyed by their own excretions, which undergo an acid degeneration.

As has been shown in another part of this work, the two poles of a continuous current have certain peculiar properties that are in diametrical opposition. This is just as applicable to the destruction of germ life as it is in the treatment of menstrual disturbances, where one pole increases the flow, the other decreases it.

The positive pole evolves oxygen. Oxygen is an acid maker and the germ laden tissues in contact with or adjacent to this pole are made acid, and whenever we render the habitation of germs *acid* we make it untenable. The positive pole, then, is germicidal in all degrees of intensity, but the negative pole *sets the table for* pathogenic germs by making a fertile soil for their propagation—an alkaline medium.

How extremely careful we must be, therefore, when making an intrauterine application with the negative pole. We have the woman take an antiseptic douche before coming to the office, mop off the os with an antiseptic solution and see that the electrode is *clean* before entering the uterus, because germs that might be carried up from the vagina—which is the natural habitat of many pathogenic germs—will be placed in a fertile soil for their reproduction. In making a positive intrauterine application, however, it is unnecessary to take any of these precautions, because the germs that may be carried up from the vagina are destroyed when exposed to the action of the positive pole. If the electrode happens to be composed of copper, we have rendered the application still more aseptic by a deposition of the salts of copper into the tissues which has eight times the microbicidal power of the *polar* effect alone. (See Endometritis.)

While the microbicidal action of the current in the *interpolar* space seems to be doubted by most writers, the author believes it to be feebly antiseptic on account of the heat evolved along the path of the current. Whenever we pass a current of electricity over anything that resists it, heat is evolved, or part of the electrical energy is dissipated into heat energy, and the most heat is evolved at the point of the greatest resistance. It is evident, then, that the passage of the current through the tissues heats them.

We learn, from the experiments of Bernard, that the bacillus of recurrent fever is destroyed at a temperature of 102; the bacillus of typhoid is not only inhibited but destroyed at temperatures of 104 to 105; even gonococcus is inhibited at temperatures over 100, therefore it must be that the current will destroy germs in the interpolar space in proportion to the strength in which it is used.

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CHAPTER XXIII.

SOME PRACTICAL POINTS IN INTRAUTERINE APPLICATIONS.

The vagina being the natural habitat of many pathogenic germs, it becomes necessary to exercise antiseptic precautions in entering the uterus, as otherwise germs may be carried into it and cause much disturbance.

It is generally sufficient to have the patient take an antiseptic douche before coming to the office, mop off the os with an antiseptic solution, and see that the electrode is clean. The latter, however, is not so easily accomplished, because it cannot be boiled on account of injury to the rubber insulation. To clean an electrode for use within the uterus, it is best to wash it thoroughly with a stiff brush and soap, then immerse for ten minutes in a 95% solution of carbolic acid and rinse off in a 5% solution of the same.

This process of cleaning only applies to electrodes intended for use on the negative pole, which is not germicidal. If, however, the instrument is to be used in connection with the positive pole, it is not necessary to take any of these precautions, the reason for which is stated in Chapter XXII.

A point is the most active part of an electrode, consequently is dangerous unless certain precautions are taken. If the instrument is introduced into the fundus and the end pressed against the uterine wall, we will make a sore point if the positive pole has been used, or a sloughing of the tissue if the negative has been the active pole. It is well, therefore, after introducing the electrode as far as it will go, to draw it back a trifle before turning on the current, or better still, dip the point of the instrument in shellac varnish and allow it to dry before using.

It has been quite a common practice in making intrauterine applications to use an all-metal sound and then protect the vaginal wall by pushing a rubber muff up to the external os (Fig. 21). This practice cannot be too strongly condemned and has caused much trouble in the past. It is a well-known fact that the most electrical energy is expended at the point of the best contact, because of lessened resistance at that point, and if an electrode within the uterus is active throughout the entire tract—from the external os to the fundus—the point of best contact is at the internal os. We will then have excessive cauterization at that point long before the endometrium above is attacked at all, with the result of making a ciccatrix that will bring its quota of suffering to the unhappy patient.

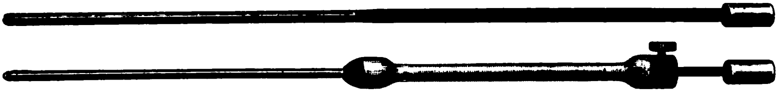


FIG. 21.

The electrode best adapted for intrauterine applications is shown in Fig. 22. The active point being only about one and one-fourth inches in length allows the internal os to be protected by the hard rubber insulation and thus avoids the danger outlined above.

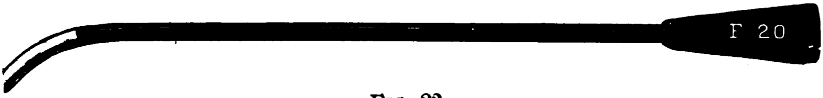
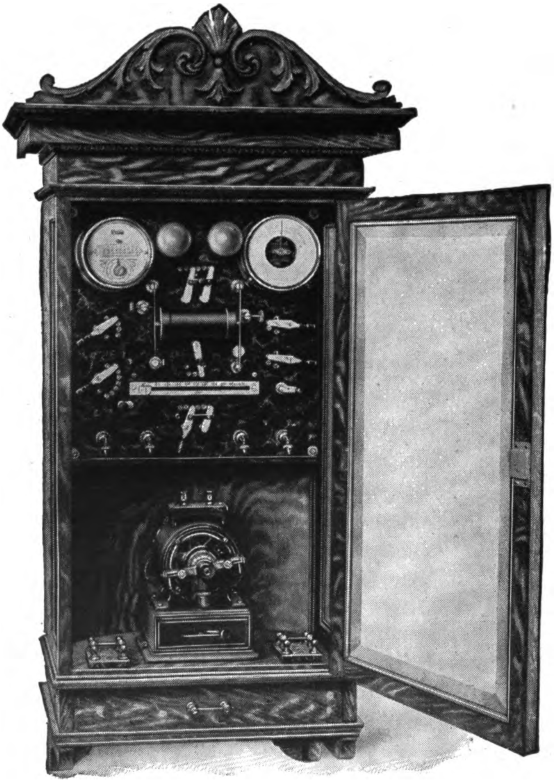


FIG. 22.

The use of negative galvanism within the uterus often gives rise to uterine colic, more or less intense, caused by the accumulation of hydrogen bubbles which act as an irritant. The late Dr. P. S. Hayes was probably the first to call attention to this, and had constructed an electrode with a hollow tip that discharged the hydrogen froth into the vagina as fast as it was formed. The instrument, however, was uncleanly, fragile and unsatisfactory and went rapidly into disuse. The trouble may be avoided by gently dilating after each application.



THE AUTHOR'S WALL CABINET.

CHAPTER XXIV.

DYSMENORRHEA.

While this distressing symptom—and we speak of it as a symptom—is usually divided into many forms, viz., neurotic, congestive, obstructive, membranous, etc., the author believes most cases of painful menstruation to be due to undeveloped uterus and obstruction of some kind.

Infantile uterus is one of the great causes of dysmenorrhea and sterility as well, and the more we look for it the oftener we find it. How common the picture of the patient who comes to us with a history of dysmenorrhea—generally amenorrhea—since the age of puberty. She has been married from five to fifteen years, but was never pregnant. Wants children, probably because she knows she is sterile.

We examine this patient and find a pin hole os and a uterus about 1½ inches in depth, or a long cervix ending in a fundus about as large as a hazel nut and scarcely any muscular fiber in either.

Dilatation is the usual practice of the gynecologist, but dilating the uterine canal will not make muscular fiber or cause the organ to grow, and he is just as powerless to successfully cope with this condition without electricity and a knowledge of its use as is the blacksmith to make a horseshoe without a hammer. Lack of nutrition is the primary cause of the trouble, and in the renewal of the nutritive processes depends our cure.

The advantage of early treatment is apparent to every thinking physician, for he realizes that, in time, the uterus from lack of support drops back into the hollow of the sacrum, the hard fæces rasp over the fundus, inflammation ensues with its consequent adhesions, and the woman is an invalid.

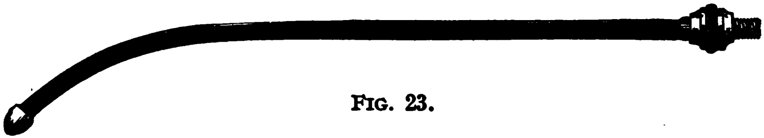


FIG. 23.

For the treatment of these cases we require both galvanism and sinusoidal. A small metal olive—about No. 10 French—mounted upon an insulated staff (see Fig. 23) is attached to the negative pole of a galvanic battery, the positive being a large pad, well wetted and placed upon the abdomen. A vaginal speculum is now introduced and when the external os is well exposed the olive-pointed electrode is introduced into the edge of the canal—it will not enter it—and the current gradually turned on by the aid of the rheostat until from five to seven milliamperes are reached. Just enough pressure should be used to keep the electrode firmly in contact with the mucus membrane. Hydrogen froth will be seen coming out around the edge of the olive, the alkaline action of the negative pole causes the tissue to become soft and slippery, the instrument goes slowly forward until it passes the internal os and is in the fundus.

We have now enlarged the uterine canal a little, and although the action of the negative pole is stimulating, it is not sufficiently so to increase muscular cell growth, so we leave the electrode in place, turn off the galvanic and switch on the slow sinusoidal current for purposes of massage.

This current not only conduces to increase the muscular fiber of the uterus and its attachments, but stimulates the absorbents to take up the products of decomposition set free by the first part of the application.

If the apparatus happens to give only one rate of interruptions—the rapid—good massage can be had by cutting the current up into periods, by means of the automatic rheotome, as has been described in another part of this work.

At the second treatment, which should be in about three days, we employ the same sound, introduce it *without* the aid of galvanism and use only the faradic massage.

For the third sitting the sound is increased in size by one number, introduced by the aid of the negative pole of the galvanic as in the first seance and followed by sinusoidal massage.

As it is much easier to increase the lumen of the canal than the muscular fiber of the organ, we should only continue the increase in the size of the sound up to a certain point, when we can omit the galvanism and use only massage.

It is hardly necessary to state that these treatments should be given with due antiseptic precautions, because it is a well known fact that neither *negative* galvanism nor faradism are germicidal. An antiseptic vaginal douche before coming to the office, mopping off the os with an antiseptic solution and seeing that the electrode is clean, are necessary precautions.

In many cases the author has developed a uterus 1½ inches in depth up to 2½ inches in eighteen or twenty treatments by the technique herein described.

Obstructive dysmenorrhea generally comes under the head of stenosis, the treatment for which is given in detail under "urethral stricture."

The next form of dysmenorrhea for our consideration will be one that is the rarest of all forms, the most painful of all forms and yet the easiest to treat by electrical means, although its successful cure by other measures has always been considered very difficult—we refer to membranous dysmenorrhea. If we briefly consider the pathology, the remedy for this distressing lesion will suggest itself if we are fully conversant with the polar effects of galvanism. The endometrium in the place of assuming that fluffy, fertile appearance that it does every twenty-eight days for the reception of the ovum, commences directly after the menstrual period to harden, and keeps on hardening up to the time of the next menstrual flow. The menstrual blood dams up behind it, causing much pain by pressure, and the endometrium has to be born by the aid of uterine contractions with all the pains of childbirth. Many patients treated by the author have declared that they would just as soon endure the pains of labor as to go through a menstrual period. The remedy we depend upon, therefore, is one that will keep the endometrium in a soft or liquid condition, and here is strongly indicated the use of the negative pole—the use of negative galvanism. The treatment should be commenced directly after a menstrual period and consists in the use of an intrauterine electrode, having a metal tip about 1¼ inches in length, mounted upon an insulated staff (see Fig. 22). This is attached to the negative pole of the battery, the positive being attached to the abdominal pad. By the aid of a vaginal speculum the os is exposed and the electrode carefully inserted into the fundus. The current is now turned on until from 30 to 40 milliamperes are reached, which is maintained for 10 minutes. This treatment should be given about twice per week until the time for the next menstrual period. The endometrium in the place of being hard and having to be cast off in shreds or as a whole has been kept softened and liquefied by the action of the negative pole and now passes off as menstrual fluid. The author has not treated any of these cases longer than to cover two menstrual periods, and although he has record of cases being treated five years or more ago he has not heard of a return of the trouble. The polar effects of galvanism are more noticeable upon the menstrual function than elsewhere because the galvanic current does its best work through the vaso-motor system. With galvanism we may do with the menstrual function what we will. We may increase it; we may decrease it; we may stop it. Take for instance a case of menorrhagia the blood vessels of the pelvic viscera from vaso-motor disturbances are relaxed and patulous; the muscular walls have lost their tone and will not contract and expel the engorgement. The woman bleeds one-fourth of the month—in many cases being almost exsanguinated—and spends the other three-fourths to recuperate, merely to repeat the process over. This is just such a condition as would be produced by the application of the negative pole of a galvanic battery, and requires the application of the positive pole. The treatment is simple. We take the ordinary ball

FIG. 24.

vaginal electrode (see Fig. 24), cover it with a pad of absorbent cotton, well-wetted, and place it well up in the posterior vault of the vagina attached to the positive pole, the negative being the usual abdominal pad. In such cases we employ a current strength of from 30 to 40 milliamperes for 10 minutes, and repeat the treatment three times per week for the three weeks preceding the menstrual flow. Physicians who have not tried this means of treating a very common trouble will be surprised at the next menstrual period being almost, if not quite, normal.

Now take the opposite condition—that of amenorrhea where the pelvic viscera again from vaso-motor disturbance is in an anemic condition. The muscular walls of the blood vessels are contracted, the lumen of the blood vessel is lessened; the blood supply to the part is decreased, and the woman at the time of her menstruation has merely a show for one or two days. The menstrual blood that should have passed off as waste matter is taken up by the system and causes the patient much inconvenience in the way of headaches, sleeplessness, etc. For this condition our remedy is negative galvanism. This pole, as is well known, is a powerful vaso-motor dilator, increasing the lumen of the blood vessels and bringing an increased blood supply to the part. We use the same dosage and employ the same electrode as for the treatment of menorrhagia.

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CHAPTER XXV.

MALPOSITIONS OF THE UTERUS.

One of the commonest pictures presented to the gynecologist is a retroverted uterus bound down by adhesions. This condition is also responsible for much of the invalidism in otherwise healthy women.

It is primarily attributable to a lack of the nutritive processes of the uterine attachments, although other causes such as subinvolution and infectious lesions may contribute largely to its existence.

The office of the round ligaments is to hold the uterus in a forward position, but when these lose their muscular tone and are not able to hold the uterus in a normal position, it falls back into the hollow of the sacrum, where the hard fæces passing through the rectum irritate the fundus, causing it to become inflamed with the consequent throwing out of exudates and the resultant adhesions.

The popular operation of shortening the round ligaments—Alexander's operation—seems irrational, when we consider that good operators often have considerable trouble to locate these ligaments because they have not sufficient muscular fibre to make them thicker than a coarse thread Under such conditions, how could we expect them to hold the uterus forward, be they shortened ever so much? Ventral fixation offers even less hope of permanent relief, because the uterus, pulling against the abdominal wall, is always a source of constant irritation.

The adhesions must first be broken up, and to do this requires the softening action of the negative pole, but this pole is irritating as well, and if the inflammation that caused the adhesions is still present in a subacute stage the use of this pole will aggravate the condition. If now we employ the positive pole to cure the inflammation, we must, of necessity, harden the exudate that has been already thrown out, and this the author prefers to do, because he considers it better to cure the inflammation and stop the throwing out of more exudate, even if it does harden those already existing. For this purpose the ordinary vaginal electrode, Fig. 24, is employed, and after being covered with absorbent cotton and attached to the positive pole, is introduced into the vagina against the mass of adhesions and the usual current strength of from 25 to 40 milliamperes allowed to flow for ten minutes. The seances are repeated thrice weekly until all trace of soreness and inflammation has subsided.

It might seem apparent to a casual observer that if we now use the negative pole for the purpose of breaking up the adhesions, we are in danger of reproducing the original condition, but it must be remembered that while the negative pole is irritating it does not produce a true inflammation, but only a condition simulating one.

The same electrode, after being covered with wet cotton, is now attached to the negative pole and after being placed against the mass of adhesions, the same current strength is employed for ten minutes. Without removing the electrode the galvanic current is now turned off and a *slowly* interrupted faradic current, of a strength easily borne by the patient, is used for about five minutes. This will hasten the absorption of the products set free by the use of the negative pole. It is always good practice to follow an application of negative galvanism with a slowly interrupted induced current, and, with few exceptions, the writer always does so, because the massage stimulates the absorbents to do better work.

The uterus now being free of adhesions, we will take an intrauterine electrode (Fig. 22) and under strict aseptic precautions, introduce it to the full depth of the uterine canal, then using the electrode for a repositor, lift the organ into its proper position. The main point to be borne in mind regarding these cases is, never to treat the uterus out of its normal position.

We will now turn on a slowly interrupted induced current for purpose of massage, which will not only hasten involution in the organ, but so increase the muscular tone of the round ligaments as to enable them to perform their function. The patient should now be placed in a knee-chest position and an ichthyol and glycerine wool tampon introduced so as to keep the organ in as near a normal position as possible until ready for the next treatment.

PROLAPSUS.

Here we have, again from nutritive disturbance, a weakened condition of the broad ligaments, allowing the organ to come down so low as to oftentimes protrude from the vulva—procidentia. The treatment in this instance is devoid of the danger of infection and the results are more

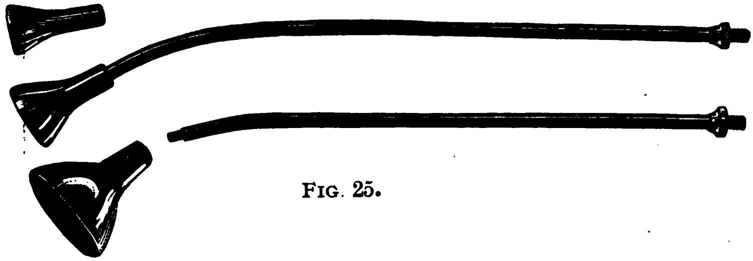
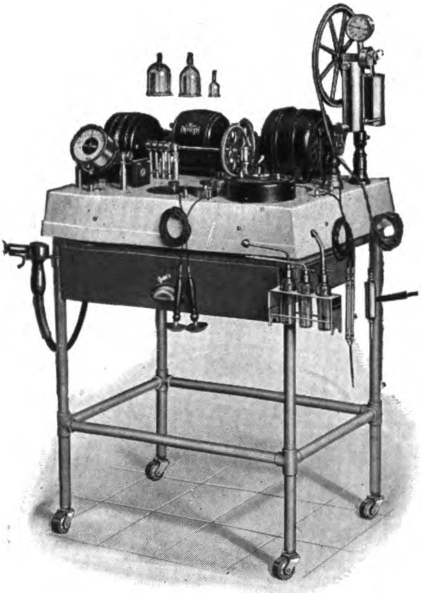


FIG. 25.

quickly apparent than in the treatment for retroversion, because it is not necessary to enter the uterus.

The os is placed in a uterine cup electrode (Fig. 25) and the organ pushed up into a normal position, after which a slowly interrupted induced current is used for five minutes, or a little longer, and the seance repeated every second day. A retaining tampon may be introduced after each sitting.

The author has had many cases of almost complete procidentia entirely recover by the use of the above simple technique.



A UNIVERSAL ELECTRO-THERAPEUTIC APPARATUS AFFORDING ALL LOW TENSION CURRENT MODALITIES.

CHAPTER XXVI.

SOME DISEASES TREATED BY METALLIC CATAPHORESIS.

HEMORRHOIDS.

I have not a great deal to add to my former contributions to the subject of treating hemorrhoids, especially to that contained in my book (18th edition); therefore, I may be excused for calling attention to or quoting from my former writings, some of which date back to the year 1895.

I have an abiding faith in surgery for the relief of this troublesome and common lesion; but if everyone so affected would consent to operation, there would not be enough rectal surgeons to go around. Fortunately, however, the great majority of these cases which the physician is called upon to treat are not thought severe enough to warrant surgical interference, and these are the cases that can be permanently relieved by electrical means. If the case is very bad, I always advise operation, but I now believe that many that I have refused to treat might have been wholly or partly relieved by patient treatment.

The rectum is a great reflex center. If our patient is dying from chloroform narcosis, we stretch the sphincter ani, and he is relieved. If a child has spasms, we do the same, and lo, it is relaxed. All of which goes to show that we must be cautious in our manipulations at this point if we would avoid causing some reflex disturbance.

While constipation has always been thought to contribute largely to the etiology of hemorrhoids, there are other and more important causes, the consideration of which will lead us to means of prevention as well as cure. Constipation has not so much a tendency to cause as to aggravate already existing hemorrhoids.

This lesion is evidenced by dilatation of the rectal blood vessels, a turgescence, which we know is due to some vaso-motor disturbance. The walls of the blood vessels are composed of involuntary muscular fibers and, as such, are supplied by the vaso-motor nerves which control all involuntary or nonstriated muscular fibers.

In the body we have many balancing and compensating systems that keep it in perfect equilibrium. In the nervous system we have the vaso-motor balanced by branches from the sympathetic, which are inhibitory. Whenever this balance is interfered with, we have vascular troubles. For instance, if we stimulate the vaso-motor fibers, the inhibition exerted by the sympathetic is overbalanced and the vessel is dilated; on the other hand, if we produce sedation of the vaso-motor, the inhibition exerted by the sympathetic has no balancing power, and the lumen of the vessel is lessened.

I am not unmindful of the fact that what I have here written is directly in opposition to the teaching of most physiologists who assert that stimulation of the vaso-motor always produces contraction of the blood vessels; but these assertions all depend upon the kind of stimulation, or whether the stimulation to which they refer might be in fact a sedation.

Landois ("Textbook of Human Physiology," p. 763) aptly explains my position thus: "When the center is irritated electrically, it has been found that single inductive shocks of moderate strength are effective only when two or three shocks occur in a second. The maximal vaso-constrictor effect, which can be recognized from the maximal blood pressure, is observed as a result of from ten to twelve strong, or from twenty to twenty-five moderately strong, shocks in one second." Slow induction shocks produce stimulation, but rapid shocks, by producing tetanism, destroy the function of the nerve by producing sedation. Thus, hemorrhoids may be greatly relieved by induction currents, if they are very rapid.

If the positive pole of a constant current is applied to a vaso-motor nerve, sedation is the result, with consequent lessening of the lumen of the vessel by placing the muscular walls entirely under the influence of the sympathetic fibers, which act by inhibition. If the negative is applied, we have the reverse effect.

The question here arises, Why does not the current affect equally the vaso-motor and the sympathetic fibers? For the reason that the vaso-motor fibers are all medullated from their origin to the sympathetic cord, and consequently are excellent conductors; the sympathetic is characterized by the presence of nonmedullated gray fibers, which are very poor conductors. As electricity takes the path of least resistance, it expends the most of its energy on the vaso-motor or medullated nerves, except in cases of high frequency currents, where the effects are more directly noticeable on the sympathetic.

Static insulation and other forms of high frequency modalities, especially auto-condensation, are great equalizers of the nervous forces. In two instances, when treating patients for arterial hypertension with auto-condensation, I noticed the hemorrhoids to disappear, and in three other instances I recorded the disappearance of hemorrhoids while treating patients for chronic nephritis, with static insulation. Could these cures have "just happened," or were they the result of the action of these nerve equalizing currents?

The splanchnic nerve is the vaso-motor of all the arteries and veins of the intestines, and, as such, is the chief etiological factor in hemorrhoids.

Irritation of the origin of the splanchnic in the dorsal cord—6th to 10th dorsal ganglia—produces inhibitory effects only so long as the blood in the capillaries has not become venous. In hemorrhoids, the blood has already taken on that condition, and irritation produces the opposite effect—that of dilatation.

All of us no doubt would prefer to treat the primary cause of the lesion rather than any symptoms. Unfortunately, however, it takes much time to relieve a case of hemorrhoids by the method here given. Even if we produce sedation of the dorsal ganglia by the application of positive galvanism, or the rapid sinusoidal current, the time consumed is considerable and the patient quits at about the time when visible improvement is becoming manifest.

It becomes necessary, therefore, to treat the hemorrhoids, per rectum, as a symptom; which in my hands has always yielded good results and satisfied the patient. After all, what does the patient care about reflexes and the action of the splanchnic nerve, if he can be relieved sooner through another channel? Besides I suppose he is just as likely to have a new attack, whatever method may be employed for his present relief.

A former process, and one that had many advocates, was galvano-puncture. A needle attached to the negative pole was introduced into the tumor and sufficient current employed to produce decomposition of the blood, such products of decomposition being taken up by the absorbents, or a platinum needle from the positive pole was plunged into the tumor, with the result that a firm clot was formed, which it was also expected the absorbents would take care of.

It must be remembered, however, that the patient is in great danger whenever products of decomposition are set free in the rectal circulation, first from hepatic embolism, by entrance of these products into the superior hemorrhoidal vein, thence to the inferior mesenteric and through the portal vein to the liver; second, a cardiac embolism, from the middle or inferior hemorrhoidal to the internal iliac, to the common iliac and through the inferior vena cava to the heart. It is even dangerous to inject a hemorrhoidal tumor with carbolic acid for the same reason. Moreover, all such operations are productive of so much pain as to bring them beyond the limits of tolerance of most patients.

In looking briefly into the pathology of hemorrhoids, we find a relaxed condition of the rectal walls, causing prolapse at stool; a dilatation of the blood vessels, pain and inflammation. Just such a condition as would be produced by application of the negative pole and therefore requiring an application of the opposite or positive pole. As this pole, by its acidity, coagulates the albuminoids of the blood and hardens tissue, it is almost impossible to have a prolapsus of the rectum after the first treatment. Being a powerful vaso-constrictor, it lessens the lumen of the blood vessels, thereby overcoming the existing turgescence, and it must be borne in mind that these hemorrhoidal tumors, being benign, take on the principal characteristic of all benign tumors, i. e., when their nourishment is interfered with they retrograde. The positive pole allays the inflammation and stops the pain.

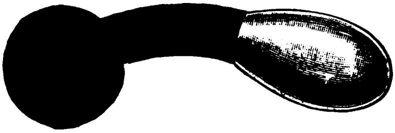
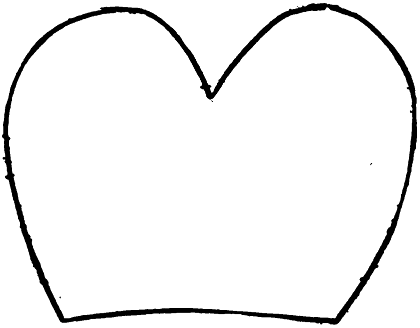


Fig. 26.

It therefore becomes evident that we have in this pole a remedy to meet all the symptoms and all that is required is a suitable electrode for its application. This, as shown in Fig. 26, is composed of a copper bulb mounted upon a short insulated staff with a receptacle for the cord tip in the proximal end. When this is inserted the sphincter grasps it near the end on the insulated surface, and it requires no further attention from the operator.

When we realize the great importance of the rectum as a reflex center, we become aware of the caution necessary in making even a simple application of galvanism. In the first place, we cannot afford to attach a bare, metal electrode to the positive terminal and apply to the mucous surface of the rectum, because by sticking, it might make a worse condition than the one already existing. The electrode must be covered closely as the cover on a ball, with part of an old kid glove (a working pattern of which is herewith shown, actual size), being sure that the seam is drawn closely so as not to expose any of the metal.



Working Pattern for Covering of Electrode.

The author was at first accustomed to wet the covering with water only, but in many cases where the tenderness was excessive found it impossible to introduce the electrode without lubricant of some kind. Vaseline being a non-conductor, is not suitable, and soap, by its alkalinity, neutralizes, in part, the effects of the positive pole. A formula for making an excellent lubricant for either hands or electrodes will be found on page 218. Formerly it was thought that a new covering was required for each patient, and although it may seem at first thought uncleanly, we now use the same covering for any number of patients, because it has been found that as soon as the covering has become saturated with the salt of copper, it is as aseptic as if it had been boiled in bichloride. The best method is to thoroughly wash the electrode with soap and water after using, and then immerse the covered end in a saturated solution of boric acid, leaving it there until it is wanted for use. In this way we prevent the covering from becoming dry, contracting and probably opening up the seam, and it is always ready for instant use.

The technic in detail is as follows:

Place the patient upon the table in Sims' position, wet thoroughly a pad as large as the hand, or larger, attach it to the negative terminal of the battery and place upon the abdomen. The positive is connected with the rectal electrode, which is then carefully introduced with the curved side down, pushing up with the electrode any fringe or prolapsed membrane. The current is now turned on by means of the rheostat until twenty milliamperes is reached, and allowed to flow for ten minutes. In most cases the treatment may be repeated every second day. The process here given is not intended to apply to old, hard external hemorrhoids. These may be treated quite successfully by fulguration.

In cases of small hemorrhoids that are pedunculated and can be reached, I use the galvano-cautery snare, which is clean, rapid and causes little pain.

The first thing noticeable in treating a case of hemorrhoids is the tremendous stimulus the current gives to peristalsis. It is important that the metal on the electrode has no contact with the external sphincter, as this and the detrusor muscle are both supplied from the pudendal plexus and if, during our operation, sedation is effected of the external sphincter it produces a corresponding condition of the detrusor muscle, which will cause such a sagging of the bladder that the urine cannot be entirely expelled. In fact, in treating a case of enuresis, where we have a spastic contraction of the detrusor muscle, I am accustomed, for the purpose of sedation, to apply a rapidly interrupted sinusoidal current to the external sphincter ani.

URETHRAL CARUNCLES.

While many methods have been in vogue for the treatment of these painful little growths, we have the choice between two electrical methods, either of which we feel certain offers better and quicker results than anything yet suggested. The first of these is metallic cataphoresis, which may be done as follows:

Take a suitable copper electrode—a small ball (Fig. 24) is best—and after applying a solution of cocaine to the part, attach the electrode to the positive pole and press it firmly against the meatus so that it will have good contact with all growths. The negative is attached to a pad upon the abdomen. A current of from five to eight milliamperes is allowed to flow until the characteristic green color is in evidence. After a few treatments the caruncles shrivel up and disappear. The treatment itself causes no pain, but after the sedative effect of the cocaine has subsided, some smarting and inconvenience is experienced, due, no doubt, to the irritating effect of the copper salt.

The second process, while requiring more experience, is even better and more thorough than the first and is performed as follows:

After the part has been well cleansed and anesthetized with a solution of cocaine, a small surgeon's needle fastened in an ordinary needle holder (Fig. 27) is attached to the negative pole and introduced successively into each growth near its base, employing a current strength of from one to two milliamperes until a decided blanching is obtained. As this treatment results in a sloughing of the tissue, it is important that antiseptic measures be employed.

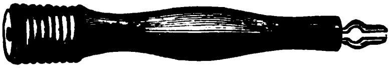


FIG. 27.

TRACHOMA.

Although not directing his attention particularly to diseases of the eye, the author believes he was the first to call attention to the treatment of this intractable disease by metallic cataphoresis,* while some improvement has been made in the technique since that time, the case then treated will serve for illustration:

Dr. . . . . ., Kansas, attending a course at the Post Graduate School, and suffering from an aggravated case of trachoma of many years' standing, presented himself at the clinic for treatment on Wednesday, May 8, but operation was deferred until Friday, May 10, in order to enable the writer to make an electrode to suit the case.

The end of a piece of No. 18 copper wire about three inches in length was beaten upon an anvil until it measured in width one-fourth inch; after being smoothed on the flat surface and edges with a piece of fine emery cloth it very much resembled a small spade with the corners rounded off. The flattened end was then bent to an angle of about twenty degrees, and the electrode as completed was fastened in an ordinary needle holder. A small amount of a six per cent solution of cocaine was dropped into the eye and when anesthesia was complete, the lid was turned up, and the copper electrode attached to the positive pole was applied to the granulated surface, the circuit being closed by means of a hand sponge attached to the negative pole and within easy reach of the patient. A current of only three milliamperes was used for ten minutes, at the end of which time the mucous lining had assumed the pale green tint characteristic of the copper salt. To prevent the electrode from adhering to the mucous surface it was very slowly moved from one point to another, but without breaking the contact. The operation caused no pain.

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*Alkaloidal Clinic, July, 1895.

The patient was present at the next clinic, Wednesday, the 15th, and reported that the eye operated upon was about well, better than it had been in many years. The color of the membrane was nearly normal, and had every appearance of being, as the doctor had represented, nearly well. A second operation was prevented by the patient being called home, and the case was lost sight of.

The treatment as herein outlined was suggested by the process in vogue for so many years, of applying cupric sulphate by means of a blue stone pencil, which, it will be noticed, always does much good, but the reason it did not make a complete cure was because the copper salt never reached the ultimate ramifications of the granular surface, while with the electrical process it undoubtedly does.

EROSIONS OF OS.

The treatment of erosions by metallic cataphoresis while quite successful, is never permanent so long as the exciting cause is allowed to continue.

Acrid discharges from the uterus due to endometritis, salpingitis and pyosalpinx, are the principal causes of erosions of the os, and should receive attention before we can hope to effect a permanent cure. As it is, however, always considered good practice not to ignore symptoms even while treating the cause, we believe it advisable to treat the erosions and keep the os in as healthy a condition as possible.

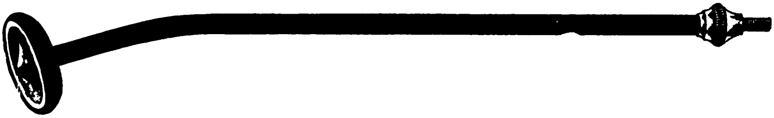


FIG. 28.

An electrode that answers the purpose admirably, and which is shown in Fig. 28, was designed by Dr. Fitz Hugh, of Denver, Colo., by taking a cast of a normal os and forming a sheet of copper to correspond to the cast. This is mounted on the distal end of an insulated staff so that all parts not intended to receive the current are perfectly protected. The diameter of the distal end is just sufficient to admit it through an ordinary working vaginal speculum, consequently the latter instrument can always be employed leaving the seat of operation in plain sight.

The electrode may be covered with a thin layer of cotton wet with normal salt solution, or be used bare, and having been attached to the positive terminal is given good, firm contact with the excoriated surface. The negative is the usual abdominal pad.

A current flow of twenty milliamperes is maintained for ten minutes and the seance repeated at intervals of two or three days until the healing process is thoroughly established.

ENDOMETRITIS.

We are pleased to note in a recent article by one of the most prominent operators in Chicago that there is only one excuse for curetting a uterus, viz., when there is something to take away, e. g., fungoid growths or detritus after miscarriage. The same writer ridicules the idea of curettement for germ lesions like endometritis, and states that it is impossible by such a procedure not to leave a nucleus for recurrence of the trouble. Very rational, it is true, but it does seem as if we should have thought of it years ago, but we are told it took one thousand years to invent a two-pronged fork and as many years to learn how to use it—some people have not learned its use yet—so there may be some excuse for such a foolish thing as curetting a uterus for endometritis even at this late date.

Only those who have used cupric cataphoresis for this condition can appreciate its curative value. Many cases treated annually at the Illinois School of Electro-Therapeutics get well so rapidly that only one class—course covering three weeks—can see them. This certainly is preferable because it causes very little pain or inconvenience to the patient, and there is no danger of infection, because both the positive pole and the copper salt deposited from the electrode, are highly germicidal. Curettement should always be done under anesthesia and never in the office. There is danger both from the anesthetic and the operation, and the inconvenience and expense to the patient is considerable.

In treating a case of endometritis by cupric cataphoresis it is well to remember that it is not necessary to take the same antiseptic precautions rendered necessary in some other electrical applications within the pelvis, in fact, it is unnecessary to even take the usual antiseptic vaginal douche, or mop off the os with an antiseptic solution, because all the germs that may be carried up from the vagina are destroyed in the presence of the copper salt and the *polar* action of the positive pole.

An intrauterine electrode (see Fig. 22) is selected that will well fill the uterine cavity; it is attached to the positive pole of a galvanic battery and introduced into the fundus. The negative is the usual abdominal pad. The current is turned on gradually by means of the rheostat until from 30 to 50 milliamperes is reached and allowed to flow for ten minutes. The seances should be repeated twice or even three times per week.

In order to prevent the electrode from sticking it should be gently rotated and as the instrument is slightly curved, this rotation will serve to carry the application of the copper salt into the horns, which otherwise would not be reached.

The author recently had the opportunity of examining a uterus which had been subjected to this treatment. The patient, a clinical one, was about to have her uterus removed and the request to make the application was readily granted by the operator.

In about one hour the uterus was handed us for examination and upon splitting it open we had the most beautiful demonstration of the efficiency of the application. Every portion of the endometrium, even to the horns, had taken on the characteristic green color of the copper salt. If there had been germs present they would certainly have been destroyed.

INDOLENT ULCERS—VARICOSE ULCERS.

The treatment of indolent, sloughing or varicose ulcers by cupric cataphoresis, probably shows the curative value of the remedy to the fullest extent. The physician who is only a tyro in the use of electricity will be surprised how soon healthy granulations will start up in the old sore. The operation may be made painless by the application of a 4 per cent solution cocaine. After cleansing the ulcer with an antiseptic solution, take a thin sheet of absorbent lint the size of the sore, and having wet it with a normal salt solution, lay it upon the ulcer and apply a thin copper electrode (see Fig. 29) attached to the positive pole over the surface of the lint until it has become almost dry. The current strength in this instance may be governed by the sensation of the patient and the size of the electrode. The lint should *not be removed* after the operation but may be left as a dressing, merely covering it with dry cotton and a loose gauze bandage. If done thoroughly, one application may be sufficient to start a healing process.

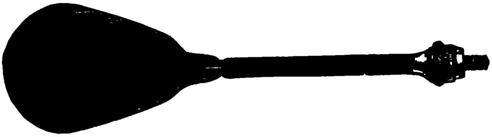


FIG. 29.

CERVICAL CATARRH.

The commonest picture that presents itself to the gynecologist as he looks through the vaginal speculum is that interminable albuminous looking plug protruding from the external os. He places some cotton upon the applicator, mops and twists, pulls it out a little and thinks he has it, but it flies back again like a piece of rubber.

He knows he has a case of cervical catarrh, but how shall he get rid of this tenacious exudate that is one of the great causes of dysmenorrhea and sterility as well? He can curette it is true, but that is an operation properly requiring an anesthetic, and the patient will not consent. Besides it is a germ lesion and there is no certainty that a curettement will not leave a nucleus for a return of the trouble.

We believe we can say, without fear of successful contradiction, that there is no disease more amenable to electrical treatment and in which the results are more permanent and easily attained than the one in question.

Take a copper electrode (see Fig. 22) that will well fill the cervical canal, attach it to the positive terminal of a galvanic circuit, the negative being a large pad placed upon the abdomen. Introduce the electrode up to the internal os and employ a current strength of 30 to 40 milliamperes. Do not move or rotate the electrode to prevent sticking, for that is just what we want. In five minutes or a little longer the instrument will be tightly stuck, but by a little traction it can be drawn out, when we will discover that all the albuminous plug has been coagulated by the acid action of the pole and has adhered to the electrode; some bleeding may follow, but it is of no consequence. If now, we examine the canal we will find the cervical glands denuded clear down to the nebothian glands. We have, in fact, curetted the cervical canal, but we have done it with little inconvenience to the patient and we have, moreover, deposited the copper salt throughout the cervical region, which will destroy the germs exerting their influence there. One or two more applications may be necessary, but each time the exudate will be less in evidence, and we have done more in a single seance than could possibly be done other than by a surgical curettement, and we cannot except that.

PYOSALPINX.

This condition has so universally called for radical operation in the past, that it would seem very unorthodox to advocate that it may be relieved by electrical means, and while the author would not advise it strongly at this time for fear valuable time might be lost to the detriment of the patient, his results have been such as to warrant its further continuance.

It is not always easy to gain the patient's consent for operation and the cases treated so far have been those in which it was positively refused. The danger of delaying operation, especially where the drainage through the uterus is good, is not so great, because it is a well-established fact that, just the same as a gonorrhea will become gleet and the gleet run itself out, so will a pyosalpinx become a hydrosalpinx and the latter become innoxious. Every physician also realizes that the danger of infection from removing a pus tube is greater than in any other operation on the pelvis.

Up to the time of this writing the author has entirely relieved hundreds of these cases, many of them *double.* A history of the first case with the technic employed will serve to illustrate. Mrs. J...., housewife, age 43, presented herself at the writer's clinic at the Post Graduate Medical School, in July, 1900. She had a profuse discharge and suffered much pain. Upon digital examination the left tube could be palpated, enlarged and sagging down as low as the internal os. A diagnosis of pus tube was made and confirmed by two of the best gynecologists in the school, both of whom advised immediate operation, which was positively refused, giving us an opportunity to employ electricity.

In this case, as well as all similar ones, the writer does not make the application intrauterine for fear of occluding the uterine end of the tube and interfering with the drainage.

An ordinary vaginal electrode consisting of a copper ball mounted upon an insulated staff, or better still, the author's vaginal cataphoric electrode (Fig. 30) covered with cotton, and after being well moistened was introduced into the vagina and placed against the tube, being guided by the finger of the operator. This was connected to the positive terminal, the negative being the usual abdominal pad. A current flow of 50 milliamperes was maintained for ten minutes and repeated every second day.

After four or five applications it was noticed that the discharge was thinner and had assumed a palish green color. This was supposed to be due to the discharge coming in contact with the copper electrode *after* entering the vagina, but upon making an examination per speculum, it was discovered that the discharge had assumed the characteristic green color of the copper salts *before* entering the vagina and proving, beyond a doubt, that the salts had penetrated the *contents of the tube.* This fact was further proven by testing the secretion as it came from the uterus and found to be sterile.

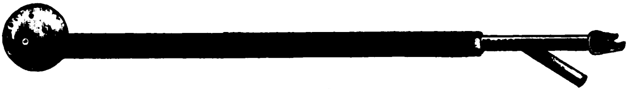


FIG. 30.

About the tenth treatment the discharge suddenly ceased, which caused the operator much uneasiness for he feared that, both from the constringency of the copper salt and the positive pole as well, the uterine end of the tube had become occluded and there would now be danger of its rupture into the peritoneal cavity. No septic symptoms, however, being apparent, the treatment was continued and the patient discharged after the twentieth seance, and although many years have elapsed there has been no return of the trouble.

Six patients, treated as described, have been kept under strict observation for periods of from three to five years, and found to have no recurrence of the trouble. One has borne one child, another has had two.

In some of the cases treated as much as eighty milliamperes has been used, and the best and quickest results have been obtained by wetting the cotton on the electrode with a saturated solution of copper sulphate.

Dr. G. Betton Massey prefers a zinc electrode amalgamated with mercury, and while good results are claimed the writer believes it to be more severe than covered copper.

HYPERTROPHIC RHINITIS.

While not intending to trespass upon the field of the rhinologist, the author's results in the treatment of this common ailment by metallic cataphoresis have been so gratifying, that he deems the simple process worthy of record.

This is undoubtedly a *true* hypertrophy, and therefore is only an enlargement of the normal cells composing the gland. In a *true* hypertrophy, therefore, we have nothing to destroy and whenever we attempt *decomposition* in order to decrease the size, we destroy the function of the gland.

The negative pole of a galvanic current acts as an alkaline caustic, softening and disintegrating tissue, while the positive *decreases the blood supply* and shrinks or hardens tissue. It is evident then that every *true* hypertrophy calls for the application of the positive pole.

The writer's technique for the treatment of these cases is as follows: A copper wire is twisted upon itself and the double end fastened into a connector, for the reception of the cord tip. About three inches of the distal end is loosely wound with absorbent cotton, which is well wet with adrenaline chlor. After cleansing the nasal canal with a douche, the electrode as prepared is attached to the positive pole, and introduced well back into the nasal cavity, the negative being a pad the size of the palm of the hand placed on the back of the neck. From three to five milliamperes may be used for five minutes. If both sides are to be treated, do not use a double nasal electrode, but treat each side separately. The seances may be repeated thrice weekly.

In this treatment we utilize the *polar* effects of the positive pole, the copper salt and the suprarenal extract, and those who are not acquainted with the process will be surprised at the rapidity with which results are obtained.

FISTULA.

Those who have treated fistulous tracts by metallic cataphoresis are enthusiastic in praise of the method, and, in the author's experience, the results have been everything that could be desired. By the aid of a local anesthetic the treatment may be given with little or no pain, the patient is not obliged to quit his usual work and the results are as permanent as can be obtained by the most radical surgical procedure.

If an operation is done it necessitates dissecting out the pyogenic membrane, which must be productive of much scar tissue, while if metallic cataphoresis is employed the pyogenic membrane is rendered sterile and a healing process is established to the full extent of the fistulous tract, leaving a cicatrix so small as to be scarcely noticeable after a few months.

Surgeons have criticized the treatment of fistulous tracts by metallic cataphoresis, claiming that if the tract has branches only one will be cured, while those not reached by the electrode will form new tracts. While this is true the same objection exists when surgery is resorted to, because it is well-known that fistulas recur after operation because the branches are not reached, and moreover, if only a single tract exists infected tissue is often left for the nucleus of another tract, which latter does not occur in the electrical process.

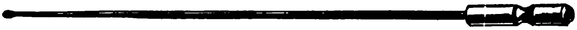


FIG. 31.

A probe pointed copper wire (Fig. 31) that will well fill the fistula is introduced to the *full depth* of the tract and attached to the positive terminal, the negative being a well-wetted pad the size of the hand or larger. The amount of current employed depends upon the extent of active surface on the electrode. For instance, if the tract be a very small one it might require only about five milliamperes, while in others of larger caliber as much as twenty to twenty-five milliamperes could be used. At least three or four days should elapse between treatments when a smaller wire must be used at each subsequent sitting.

Although it has not been tried the author believes that a fistulous tract may be entirely relieved at a single seance if sufficient current density be employed to thoroughly saturate the pyogenic membrane with the copper salt.

In rectal fistulas that penetrate into the bowel the finger should be used to determine when the electrode has reached a proper depth, and thus avoid making a sore point on the opposite rectal wall. The same caution is necessary when treating a urethral fistula, and a hard rubber sound should be introduced before attempting to use the electrode, as otherwise we may injure the urethral wall with the point of the electrode.

The copper electrode may be gently rotated to prevent sticking, but it is not a serious matter to have it stick and use traction to remove it. The current may be reversed to free the electrode, but it is not considered good practice to do so.

While the statement has been made on page 194 that I prefer the copper to the zinc electrode, I have lately made some observations in the treatment of epithelioma and other superficial malignant growths.

The subject matter following may not be new to many of you. For years zinc cataphoresis has been employed in the treatment of various lesions, but not in the manner described herein. Lewis Jones (Brit. Med. Journal) was the first to suggest its use in the manner described herein, in the treatment of small superficial malignancies.

While there is no doubt of the efficacy of the Roentgen ray for the relief of these growths, the process takes much time and is not devoid of danger. In the use of zinc cataphoresis, however, a perfect result may be had without danger or pain, oftentimes in a single treatment.

Besides epitheliomas, the process is just as efficacious in the treatment of lupus patches, and that terror of all physicians, varicose ulcers. In fact, all non-healing, indolent ulcers respond quickly to the same technic, which is as follows:

The ulcer is made clean with hydrogen peroxide or boric acid solution and a pledget of cotton saturated with a 10% solution of cocaine is wound around a block tin electrode of suitable shape and attached to the anode of a constant current. The cathode is the usual pad of absorbent cotton so placed as not to be under the control of the patient. The anode upon which the cocaine has been placed is now applied to the ulcer and a current strength of from 5 to 10 ma. is maintained for about five minutes, or until complete anesthesia of the part is apparent.

The cotton is now squeezed with the finger until it is as dry as possible and dipped into a saturated solution of zinc sulphate and again applied to the sore, using a current strength within the limits of tolerance of the patient, which is usually about 10 ma., until the ulcer has assumed a decidedly blanched appearance. Every portion of the sore must be treated until it turns white. No particular care need be taken to prevent contact with the sound tissue immediately surrounding the ulcer. It will not be affected.

In a day or two the surface of the ulcer turns black, and about the fourth day the crust can be removed, leaving a smooth healthy cicatrix.

The case should now be watched for a few weeks for any small nodules that may appear in the margin of the sore. If any appear, they should be treated in the manner heretofore described, but these nodules will not appear if the operator does the primary operation thoroughly.

Many failures of zinc cataphoresis have been reported, but it is only because it was customary to use an amalgamated zinc electrode, from which the zinc ions are not so easily separated, nor do they penetrate so deeply as when the zinc sulphate solution is employed.

While I would use the Roentgen ray for extensive cases of lupus, a few small patches are just as effectively treated by the method described, and much time saved.

Considerable irritation is caused by the operation, and I have often wondered if this had not much to do with the cure, especially in the case of varicose ulcers, where a determination of much blood to the part is always valuable.

As the three layers of skin are involved in these operations, scar tissue must always be expected.

CHAPTER XXVII.

ELECTRO-DIAGNOSTIC POINTS IN NERVOUS DISEASES.

The author is not unmindful of the fact that many of his readers may be well posted in electro-diagnosis, but the whole subject is made so difficult and is so confusing, even to most neurologists, that it is only employed by medico-legal experts to mystify the jury. It is a well-proven fact, however, that there is no better aid in the diagnosis of most nervous diseases than electricity.

It is the purpose of this chapter to deal with some of the *simpler* phases of the diagnostic capabilities of this force, more particularly those pertaining to the use of faradism, because, while a few neurologists have complete outfits, the majority have only a portable faradic battery. We will then endeavor to get the most out of this battery, first remembering that the current produced by it is more mechanical than medicinal, and while some other currents—notably the galvanic—do their work by producing chemical changes in the tissue traversed, this current does not, for the principal reason it has not the amperage and is alternating.

The faradic current produces muscular contractions by irritating the nerves that supply them. It, therefore, stimulates muscular cell growth. The physician should remember that it does just as much harm to *over-stimulate* a muscle as it does good to stop within certain proper limits, and one of the principal faults in using this current is to prolong the application beyond the point of fatigue. Nothing can be more misleading than to say of faradism "if little will do good, much will do more."

If some of you should go on the farm and attempt to do even an hour's work at splitting rails, the next day your muscles would be so sore you could scarcely move, but you may engage in the same hard labor for ten minutes today, twenty minutes tomorrow and gradually increase the time until you could do a full day's work and all the time be improving the tone of the muscles. Just so with faradism. It is simply *work* for the muscles, but as the impulse to contract or use them in this instance is *not* sent out from the brain, we are not cognizant of *how much* work they are doing. Give the patient short seances at first.

The perfect massage consists in so regulating the impulses or interruptions of the battery that the muscle may contract and come back normally between each interruption. Many physicians will use an ordinary faradic battery, giving anywhere from five thousand to ten thousand interruptions per minute, which could only tetanize and tire out the muscle, and discover when too late that the atrophy they were treating has been made worse.

Good massage—yes, the most perfect—can be given with a very rapidly interrupted faradic current if it is broken up into periods of the proper length, because at one instant the muscle is tetanically contracted, the next instant normal. This is most conveniently done with an accessory now placed on nearly all batteries, called an "automatic rheotome," in which the interruption may be perfectly controlled from 8 up to 600 per minute.

The foregoing facts are intended as hints for neurologists who are using this modality for purposes of massage, to prevent further atrophy in paralyzed muscles. We will now briefly consider the same current from a diagnostic standpoint.

1. If the pain of a neuralgia is *relieved* by pressure upon the part—many of them are—faradism alone will cure that neuralgia, but if the pain is made worse by pressure faradism is *not* indicated and resort must be had to positive galvanism or some form of static electricity. The fact was strikingly portrayed in a recent article in a medical journal, in which the writer presented three cases of ovaritis treated by faradism. Two of the cases improved rapidly and were finally cured, but the third case the writer says, "every time the current was applied the patient suffered intense pain and was made so much worse that I concluded it was *not a case for electricity,* so it was referred to a surgeon." In the history of the first two cases the writer distinctly states that there was *no pain upon pressure* over the ovaries, but of the third case "the pain upon pressure *was intense.*"

2. If a mild current of galvanism within the pelvis causes pain and that pain *can be relieved* by the rapidly interrupted faradic current, there is no pus present in the adnexa, but if the pain caused by the galvanism *cannot be relieved* by a rapidly interrupted induced current, you will *always find pus* when you operate. The physician need never be in doubt as to whether he has a case of pyosalpinx or simple ovarian neuralgia, if he will recollect this diagnostic fact.

3. Is a paralysis due to a brain lesion or does it emanate from a motor cell in the cord? This is all important because the treatment varies materially and oftentimes what will be beneficial in one variety will be absolutely harmful in the other.

It is hardly necessary to remind you that the axon from a nerve cell in the brain never goes *directly* to supply force or nutrition to a muscle, but goes down and helps form the great axis cylinder, to a cell in the cord, and from there is distributed to the muscle. It will be readily understood then that if the cell in the cord is at fault the nutrition to the muscle is *directly* interfered with, but if the lesion is cerebral, the nutrition is not disturbed, because it is kept up through the reflex arc in the cord.

This will account for the irritability of the muscles we often have in brain palsies and also the exaggerated reflexes.

We will suppose the paralysis is in the right leg and will prepare the patient for examination by baring both legs up to the body and placing him on his back on the table. A large pad well wetted is placed upon the abdomen or sternum and connected to either pole of a faradic battery. Having attached a small electrode to the other pole, place it upon a motor point of the normal leg (see chart, page 333) and then turn on sufficient current to get a plainly visible muscular contraction. As this contraction is only gotten at the opening and closing of the circuit, the current must either pass through the "automatic rheotome" or be *broken* up by hand. Now place the small electrode on the same motor point on the affected side and if the contraction is *less than normal,* the trouble is in the *motor cell in the cord.* If, however, the contraction on the affected side is *exaggerated* our paralysis is of *cerebral* origin.

Our main dependence in a peripheral paralysis is exercise and massage, to supply nutrition and prevent further atrophy of the muscle, this we will accomplish with faradism, in the manner stated elsewhere in this chapter. But if, as often happens, the muscle has so far lost its nutrition that it will not respond to the faradic current and therefore cannot be exercised in that way, we must have recourse to the interrupted galvanic current, because it is a well-established fact in electro-diagnosis, that long after a muscle has lost its faradic irritability and will not respond to that current, it retains its irritability to the interrupted galvanic and may be exercised by it. Just as soon, however, as the muscle regains its response to faradism, that current must be employed, and we will then know exactly how far we have advanced toward a successful termination of the case. So, while faradism is diagnostic, galvanism is prognostic.

If we get an exaggerated contraction and know the lesion is cerebral, then *massage is not indicated and will work positive harm.*

How, then, shall we treat these brain palsies? Gowers gives us little hope, and says we are justified in doing anything that offers any encouragement, because so little can be done.

The writer has had fairly good success from the following technique: A well wetted pad about 2x4 inches is made the positive terminal of a galvanic current and applied to the forehead; a larger electrode from the negative is placed at the back of the neck and a current strength of five milliamperes is allowed to flow for eight minutes; then move the positive electrode to spine—the negative as before—and use it *labile* for ten minutes with a current strength of ten milliamperes. The treatment may be given daily.

Knowing well that the passage of a direct current through any medium that fulfills all the conditions of electrolysis will produce chemical changes in direct proportion to the strength of the current, we may hope, by employing this technique, to promote absorption of the product in the brain that causes the trouble.

This method has always offered an excellent chance for the adverse criticisms of those to whom the very mention of the word *electricity* is the same as a red flag to a bull, but while it must be admitted that the method is vulnerable and the good to be derived from it problematical, the author, as well as many others, has had splendid results traceable to its use alone. The commoner criticism that the current does not pass through the substance of the brain, but follows the integument overlying the skull, has no weight in argument, because the *flashes of light,* dizziness and other phenomena noticed by the patient is proof enough that the brain itself is traversed by the current.

ARTIFICIAL RESPIRATION.

The proper use of faradism is the ideal method of restoring respiration in drowning, opium poisoning, asphyxia and the new-born infant.

Any ordinary faradic battery will answer the purpose. One electrode is placed over the motor point of the phrenic (see chart, page 333) and the other at the insertion of the diaphragm into the thoracic cavity. Do not be afraid of having the current too strong. Make and break the contact either at the battery posts or on the body about 20 or 30 times per minute, and if there is only a slim chance the patient will be made to breathe, because at one instant the diaphragm is tetanically contracted, at the next instant relaxed.

It is probably not well known that persons who are apparently killed by coming in contact with high tension commercial currents may be restored by employing the technique outlined above. Prof. d'Arsonval even goes so far as to make the assertion that, in many cases, criminals who have been electrocuted may be resuscitated by this method.

ECTOPIC GESTATION.

Extra uterine pregnancy occurs more often than most physicians imagine, but as it is the rule for the fœtus to die and absorption of the product to take place, it may not be even suspected at the time and is only revealed by subsequent operation for some other pelvic lesion.

As the symptoms very closely resemble and may be mistaken for those of many other conditions, doubtful diagnosis is the great drawback of the gynecologist and an exploratory laparotomy is often necessary to determine accurately the true condition. If a positive diagnosis could be made in the earlier stage, the mortality from the operation would be much decreased, and the labor of the surgeon made comparatively easy. This, however, can only be accomplished by electrical means, with which most gynecologists are not familiar, but which we shall endeavor to make as plain as possible.

It will become apparent to every thinking physician that the first thing necessary is to destroy the life of the fœtus, and if this can be done in the earlier stages, very little else will be necessary, for the products of conception will be taken care of by the absorbents.

The life of the fœtus is not destroyed by the *polar* effects of the current so much as by shock, so that any current like the high tension faradic, the interrupted galvanic, or sinusoidal current will serve the purpose. We make a digital examination and palpate a small mass in the pelvis. This may be a fibroid or a hematocele, or it may be an extra uterine pregnancy. We now take an ordinary vaginal electrode (see Fig. 24) and with the finger for a guide, place it against the mass, using any of the currents mentioned above as strong as the patient can bear. Use it daily if convenient and use it persistently. If we are dealing with a fibroid or other growth it will do it no good or no harm, but *any diminution* we get in the size of the mass is indicative of two things, first, that it is an extra uterine pregnancy, and, second, that the life of the fœtus has been destroyed, because it could not decrease in size until life was extinct. We may now safely leave the rest to nature, or we may use negative galvanism per vagina to hasten absorption of the product.

By this simple means we may save the patient the danger and inconvenience of a serious operation, and do it at a much earlier date than surgical procedure could be employed with any degree of certainty.

VOMITING IN PREGNANCY.

When we come to consider that this distressing accompaniment of pregnancy is due to an irritable condition of the pneumogastric, caused by reflex action, we can then realize that the usual remedies, such as ingluvin, cerium oxalate, bismuth, pepsin, hot water, etc., are utterly powerless to relieve the trouble.

While the application of high frequency currents to the neck and over the epigastrium has proven palliative, the author has had most excellent results by employing galvanization of the pneumogastric. Two ordinary sponge discs are attached to the double end of a bifurcated cord, each of which is placed over the nerve in a sub-aural position. The single end of the cord is now attached to the positive pole of a galvanic circuit, the negative being the usual abdominal pad.

A current strength of from ten to fifteen milliamperes is maintained for ten minutes, and, in obstinate cases, may be repeated twice daily.

The object being to produce sedation of the pneumogastric, a very rapidly interrupted faradic current has been employed by some operators, but while relief is more quickly obtained by this method, the results are not so lasting as those produced by positive galvanism, and, besides, if the induced current used is not *very* rapidly interrupted, injury to the fœtus may result.

CHAPTER XXVIII.

ENURESIS.

While the pathology of this troublesome lesion is still much in doubt, the fact stands boldly out that the best results in its treatment have been obtained through the use of electricity.

The theory of Ultzmann that it is caused by a disproportion between the force of the detrusor and sphincter muscles, seems to be true; in fact, the results obtained in many cases by the author's technique go far toward proving it.

If the detrusor is over-stimulated and the sphincter weak or *normal* enuresis would result, but this applies more particularly to enuresis nocturna. Enuresis diurna in every instance seems to be the result of non-development of the sphincter without any apparent involvement of the detrusor. The treatment, then, of the two varieties differs materially.

In the former variety—nocturna—the over activity of the detrusor is evidently due to an irritable condition of the vesical center in the cord which can usually be corrected by mechanical vibration, in connection with the rapidly interrupted induced current. The vibrator should give a very rapid stroke and is applied daily for only a few minutes, to those portions of the lumbar and sacral spine that are most likely to influence the pudendal plexus, through which the bladder receives most of its nerve supply. At each alternate seance a rapidly interrupted faradic current is employed, placing a sponge electrode about the size of the hand just above the pubes, the other, a very short rectal electrode. (Fig. 32.) We use a short electrode in the rectum because we can better reach the lower segment of the bladder through the external sphincter ani, both being supplied from the same source—the median and inferior hemorrhoidal nerves. If a longer electrode were used in the rectum we run the risk of adversely influencing the vesical sphincter, because the effect of the current we are using is not stimulation—which the sphincter would require—but a sedation, caused by the tetanizing action of such current and which is only intended for the detrusor.

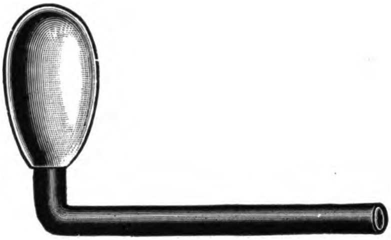


FIG. 32.

There seem oftentimes to be exceptions to the statement made by the author, that cases of enuresis nocturna do not involve, to any great extent, the vesical sphincter because several cases that were only temporarily relieved by the technique just given, were cured by directing the treatment to the sphincter, as in cases of enuresis.

The detrusor and the external sphincter ani being supplied from the same source—the pudendal plexus—it is only fair to assume that the condition of the two muscles is identical, and that they are correspondingly affected. If, now, examination of the sphincter ani be made it will be found to be in a state of spastic contraction, due to an irritable condition of the median or inferior hemorrhoidal nerve. The detrusor is in exactly the same condition from the same cause, and that is why it is often influenced reflexly, and we have such happy results by stretching the anal sphincter, which should be done in every case where practicable.

In enuresis the treatment should be especially directed to the neck of the bladder. It is purely mechanical in that it is only intended to produce muscular contractions and thereby stimulate muscular cell growth.

Direct stimulation of the vesical sphincter by introducing an electrode into the canal is, however, only practised by the writer upon females where—the urethra being short—the seat of lesion is easily reached and can be rendered thoroughly clean. It is quite a different matter with the boy, where it would be almost impossible to introduce a sound into the neck of the bladder, even under what might otherwise be considered the strictest aseptic precautions, without danger of infection or serious irritation. The latter cases are treated by placing the electrode up against the prostatic urethra per rectum.

The form of induced current best suited for purposes of massage is the *very rapidly interrupted* cut up into periods by means of the automatic rheotome. At one instant the muscle is tetanically contracted, the next relaxed, giving the most ideal massage. The principal fault of physicians in using faradism for purposes of massage is, to use it too long at a time, thus fatiguing the muscle and doing it more harm than good. The length of time may be increased at each seance, but it is not good to use it longer than three or four minutes at first. Two cases to illustrate:

Case I. Miss A. T., age 18, was referred for treatment of enuresis nocturna. She had been incontinent since six years of age, and had involuntary discharge of urine every night. She was given mechanical vibration to spine and rapidly interrupted induced current to external sphincter ani, as has been outlined elsewhere in this chapter, but was only partially relieved.

FIG. 33.

We then had a receptacle for the cord tip soldered to an ordinary metallic female catheter (Fig. 33), which, after being sterilized, was introduced into the urethra and faradic massage employed every second evening, as has been described. The patient made a complete recovery after three weeks, and has had no return of the trouble.

Case II. Mr. R. L., age 20, was referred for treatment of enuresis nocturna which dated back six years. He also had occasional seminal emissions. The prepuce being long. it was thought best to circumcise. No perceptible relief followed the operation. The urethral orifice being very small, it was enlarged in the usual manner. Still no relief. He was then given mechanical vibration to spinal center, and after four sittings began to improve. He had in all only fifteen treatments when he was discharged, and he has had no return of the trouble in one year.

CHAPTER XXIX.

URETHRAL STRICTURE.

To my friend, Dr. Robert Newman of New York, we are indebted for most of our knowledge of the electrical treatment of this common and distressing lesion.

Dr. Newman spent the last twenty years of his life in fighting for a simple operation that was only successful in the hands of a few, because, not speaking our language fluently and being a poor teacher he was not properly understood.

Dr. Newman was honest, and, if strict investigation be made of his successful reports in many thousands of cases, they will be found to be just as he has stated, and, just as often as the author has followed Newman's technique, he has had excellent success, but when he departs from it only failures result.

It is surprising, but yet true, that many physicians—good ones, too—who criticize this method, have not the least idea of what it is intended to accomplish. For instance, a physician said to the writer a short time ago, "Do you *burn out* strictures with electricity?"

The technique is simple and may be briefly given as follows: The caliber of the stricture is taken in the usual manner with any set of urethral sounds, then an olive-pointed electrode about two sizes larger than the caliber of the stricture is attached to the negative pole of a galvanic current and introduced into the urethra so as to engage the stricture. The positive pole may be a pad the size of the hand or larger on some indifferent point. The current is now turned on until five milliamperes is reached. No appreciable pressure is used, but the electrode is allowed, by its own weight, to slowly pass through the stricture, which it will do in about five minutes. The current is then turned off, the electrode withdrawn and the operation not repeated sooner than five to seven days, at which time a sound two sizes larger is employed.

The common mistake with physicians in treating urethral stricture is in not properly selecting their cases. It is worse than useless to treat an irritable, discharging, granular stricture that bleeds when you touch it, with the negative pole of a galvanic current, because it cannot but make it worse. The conditions must be favorable for the application, and, if not, they must be made so. It is not a difficult matter and may be done in several ways, some preferring a healing injection, others an antiseptic suppository. The author, however, prefers to introduce an insulated copper sound attached to the positive pole, using a small amount of current—not enough to cause the metal to stick—for a few minutes, thus depositing a salt of the copper into the tissues, which by its antiseptic and healing action soon gets the part into condition for proper treatment by the other pole.

The negative is the *irritating* pole—the one that produces a condition simulating an inflammation, and Dr. Newman in his twenty years' experience has found that five milliamperes is current enough and five minutes long enough to produce no more than a transitory irritation.

As simple as is this technique and as successful in competent hands, it seems impossible to get physicians to follow it. Almost daily the writer has conversations like the following:

"I have studied and studied, and the more I study the farther I seem to get off."

"Well, what is the trouble?"

"I have been using galvanism for the reduction of stricture, and occasionally I have some good results, but today I introduced an electrode into the urethra, engaged a stricture and when, after five minutes, I tried to withdraw the instrument it was stuck, and when I pulled it away, bleeding followed."

"Which pole did you have in the urethra?"

"I don't know."

Here is another sample:

"Doctor, I cannot obtain yours or Newman's results in treating my cases of stricture."

"Well, tell me what you did. Commence at the first and give me your technique."

"I first ascertained the exact caliber of the stricture, then selected a bulbous-pointed sound two sizes larger than this caliber and attached it to the negative pole of my galvanic battery, the positive being a pad upon the abdomen."

"Correct. Proceed."

"I introduced it carefully into the urethra and when the stricture was reached I turned on ten cells"—

"Stop right there. The proper technique never called for ten cells or any number of cells, but five milliamperes."

"But how many milliamperes will ten cells give? I have no meter."

And so it goes. A physician told the writer recently he used *thirty milliamperes* and then wondered why he did not meet with success.

STRICTURES OF THE LARGER CANALS.

In treating strictures of the larger canals—the rectum and esophagus—exactly the same principles are involved and the same procedure employed, except that we may use a current strength of ten or even fifteen milliamperes. The reason for this is that we are using a much larger electrode and the current is dissipated over much more surface, consequently fifteen milliamperes on a large esophageal sound does not give any more concentration of current than five milliamperes on a smaller urethral electrode, or ½ milliampere for eustachian stenosis.

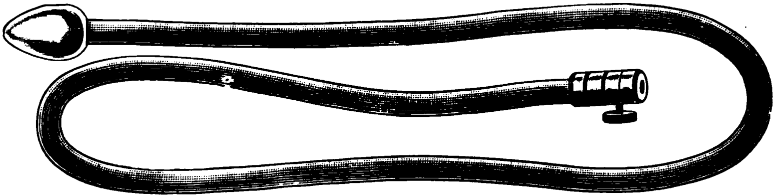


FIG 26.

There exists, however, in nearly all cases of stricture of the larger canals, a spasmodic feature that must be eliminated before we can even ascertain the caliber of the canal. This is a vaso-motor nervous disturbance and the tendency is for the canal to contract or "shut down" on anything that enters it. Many times there is no stricture. Let us illustrate with one or two cases.

Case I. Mr. J. S., a clerk, presented himself at the author's clinic at the Post Graduate hospital for treatment of an esophageal stricture. He was anemic and nervous and could only swallow the softest foods with difficulty. The stricture, which was about 1½ inches below the cricoid cartilage, was caused by swallowing concentrated lye some years previously. The patient, who had been treated by the introduction of sounds for the purpose of gradual dilatation, asserted confidently that a sound no larger than a certain size could be passed. The size indicated by him was small for the urethra, and when we selected a sound nearly three times as large, he said it would be impossible to pass it. The electrode, however, was introduced into the esophagus, and when the stricture was encountered, a very rapidly interrupted *faradic* current was turned on. This soon overcame the spasm, and the sound slipped through, much to the delight of the patient. In the after-treatment of this case a larger sound was used at each sitting, and after the faradic current was employed for a sufficient time to overcome the spasm it was switched off and the negative pole of the galvanic was turned on, using a current strength of ten milliamperes until the electrode passed. When he finally left the clinic a No. 40 French sound could be easily passed, and he was eating solid food.

Case II. Miss N. P., age 24, came from ———, Mich., to be treated for a rectal stricture. She was well-nourished and large, but gave a history of hysterical seizures, probably due to a uterine disturbance which she had. She was in the habit of taking a cathartic daily and had not had a natural action of the bowels in over a year. Upon digital examination the stricture (?) could be plainly felt and was seemingly so dense that the point of a pencil could not have been introduced. She was told to omit her regular medicine and return the next day. When she next presented herself we selected a large sound, over ⅝ inch in diameter, introduced it up to the point of lesion and turned on a rapidly interrupted faradic current. In about five minutes it passed through, and upon examination it was found there was no sign of stricture, not even a thickening of the mucous membrane.

Strictures of the larger canals, especially the esophagus, are generally due to one of three causes, viz: traumatism, syphilis and carcinoma, and if these causes can be eliminated, the operator will find he has to deal with a spasmodic contracture, which the usual treatment for stricture will only aggravate.

TREATMENT OF STRICTURES BY CATAPHORESIS.

In advocating the cataphoric application of thiosinamin for dissolving strictures of the urethra, it is not my intention to deprecate the older method instituted by my friend the late Dr. Robert Newman, of New York, which has yielded such excellent results in my hands. Indeed I would approach the subject with all due caution, for I am well aware that the reporting of immature results and deductions is the bane of medical literature.

I have thus far only treated urethral cases, and while the number has not been great, the results show such superiority over other methods as to warrant further investigation. If present indications are an index of future attainments this method bids fair to have a very wide and useful scope in genito-urinary practice, especially in those cases where the older procedures have been productive of but little good.

In the treatment of strictures by the Newman method, given in Chapter XXIX of this work, much depends on getting the part free from irritation and ready to treat. This is often a difficult matter and it is even more difficult to decide just when the irritable condition has sufficiently subsided to allow the use of the negative pole.

In treating strictures cataphorically with thiosinamin, however, the positive is the active pole, and is never contraindicated where there is inflammation or irritation present. Besides, therefore, the introduction of the medicament into the tissue composing the stricture, we have also the sedative and other beneficial effects of the positive pole. The electrode shown in Fig. 49 is almost identical, in point of construction, with that shown in Fig. 48, except that the staff is bent to a Van Buren curve and a perforated olive used instead of a ball.

So far I have found two sizes of olives to fill every indication—18F and 24F—and it will become evident to only a casual observer, that the object of the treatment being to utilize the thiosinamin in the tissue, it is not necessary to *pass through* the stricture. If the contracted portion of the urethra is smaller than No. 18F, it is only necessary to insert the olive point *up to and against* the lesion, while if the narrowed portion is larger than No. 24F, the olive point may be inserted *into* the stricture to remain the required time.

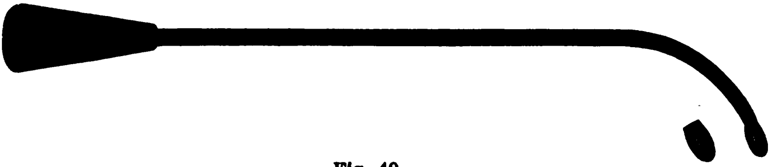


Fig. 49.

TECHNIQUE.

The same solution of thiosinamin is used as that given for the removal of scar tissue. A little absorbent cotton is wound around the platinum terminal surmounting the staff, which is then saturated with the solution and the perforated olive screwed into place.

It is always best to immerse the olive in the solution after it is in position to insure thorough saturation of the cotton with the medicament.

The instrument is then lubricated with a convenient and easily prepared antiseptic which has proven so satisfactory both for the hands and all instruments as well, that I will herewith insert the formula for its preparation:

Take one quart of saturated solution of boric acid, add one ounce best gum tragacanth and set aside for a few days until the gum is dissolved. If wanted for immediate use make the solution by aid of a water bath. A few drops of oil of lavender may be added to prevent molding. If too stiff, add a little more boric acid solution.

Attach the electrode to the positive pole of a continuous current and carefully introduce into the urethra until the stricture is engaged, then turn on current until five milliamperes is reached, which should be maintained for five minutes. The negative terminal is the usual abdominal pad or hand sponge.

The treatment should not be repeated oftener than once in five days.

As I have noted previously in this chapter that while the cases treated have been comparatively few, the results show much superiority over former methods, and warrant further investigation.

One case of seven years' standing was entirely relieved in four applications. Another case, in which a No. 14F sound could only be passed with difficulty, after one treatment admitted a No. 21F five days afterward.

PROSTATIC HYPERTROPHY.

There exists the same difference between the older methods of treatment of this lesion, as given in Chapter XVIII, and the cataphoric application of thiosinamin to the gland, as there is in the treatment of urethral stricture, and for the same reason. In both diseases the older methods call for negative applications, which are often contra-indicated by the irritation and inflammation present. In the newer method, however, the positive is the active pole and is not contra-indicated in the above mentioned conditions.

The electrode for this purpose is shown in Fig. 18 on page 145, but instead of a copper wire, we use for an applicator a galvanized iron wire.

After loosely winding absorbent cotton on the applicator for about three inches, it is saturated with the same solution of thiosinamin as that given in the first part of this chapter. The applicator is then replaced in the hard rubber receptacle and after being well lubricated with the "antiseptic lubricant" given elsewhere in this chapter, it is carefully introduced into the prostatic urethra and attached to the positive pole of a continuous current. The negative terminal is the usual abdominal pad. A current strength of ten milliamperes is gradually turned on and allowed to flow for ten minutes. The sitting should be repeated every fourth day.

I have employed this method in comparatively few cases, but my results fully justify its continuance. The first case treated was seventy-six years of age and although the old method had been used once each week for a period covering four months he was still compelled to void his urine six or seven times nightly, and the outlook was somewhat discouraging. After giving him a single treatment, as has been outlined above, he slept for eight hours without being disturbed, and improved rapidly at each successive treatment, being entirely cured and discharged in one month thereafter. In my treatment of other cases, I have noticed that the frequent desire to micturate, which is such an annoying and constant symptom of prostatic lesions, is promptly relieved in a few treatments.

EXOPHTHALMIC GOITRE.

On account of its increasing the tachycardia, due to its unfavorable influence on the vagus, it is impossible to use the negative pole for the reduction of the gland in the treatment of this trouble. Very little has been done heretofore for its permanent relief, except to quiet the nervous symptoms by the action of static electricity. Any method, therefore, tending to reduce the gland, and, at the same time, lessen the rapidity of the heart's action will certainly be gratifying to all physicians.

That the cataphoric application of thiosinamin will reduce the size of the thyroid as well as the prostate and other glandular enlargements no one acquainted with the facts can deny, and I have had several cases of fibrous degeneration of the thyroid gland which were entirely relieved by the same process.

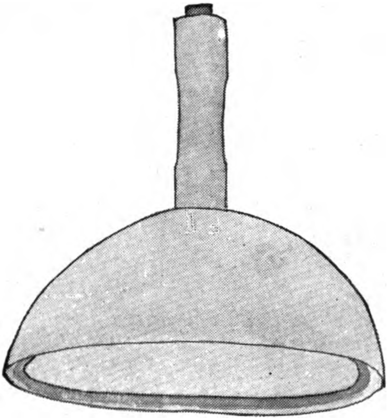


Fig. 50.

The electrode which I have devised for making these applications and which is shown in Fig. 50 is composed of a soft rubber cup, the large end of which is about two inches in diameter. About one-half way up and inside the cup is a closely fitting piece of heavy block tin fastened to a metallic staff, the proximal end being a receptacle for the cord tip. Such an electrode may be easily constructed by laterally dividing the bulb of an ordinary syringe.

The electrode is packed with absorbent cotton saturated with the same solution given elsewhere in this chapter, and, after being attached to the positive pole of a galvanic current, is applied over the enlarged gland. If the enlargement is quite extensive it is best not to have the electrode cover the entire enlargement, but to cover a small space, oftentimes necessitating applications at as many as three different points at the same sitting. In this way we get a concentration of current that would not be possible with a larger electrode. In making applications to the front part of the neck it has been the custom of many operators to place the indifferent electrode on the back of the neck. This practice has many faults and cannot be too strongly condemned. The best place for the indifferent electrode is upon the abdomen, and while I am aware that, in many cases it seems inadmissible, it can be done in every instance without inconvenience to the most sensitive patient. I take my abdominal pad, and after having it well moistened and the cord tip fastened into its receptacle, I give it to the patient who puts it into position herself in the dressing room, thus leaving the end of the cord free to be attached to the battery. The amount of current which most patients well stand is from twelve to twenty milliamperes, which should be allowed to flow for ten minutes at each point where the application is desired. Treatment should be given three times per week.

CHAPTER XXX.

THE REMOVAL OF PIGMENTARY NEVI AND CHLOASMA.

While this particular field has been boldly invaded by the surgeon and dermatologist for many years past, the fact remains that little has been done for the relief of the unfortunate possessor of these unsightly blemishes. The advance made, however, in the medical and surgical uses of electricity has made it possible to relieve those thus affected, and while the methods about to be given may not be new to some of my readers, the results obtained from their use by the author encourages the belief that they might be elaborated by others more skilful.

Nevus vasculosis, commonly known as wine marks, fire marks, etc., consists of one or more spots from the size of a pin head to one sufficiently large to cover the side of the face. They seem to be composed of a congested mass of capillaries just underlying the epidermis, slightly raised or level. In summer they assume a bright red color, while in winter they are bluish.

It is highly important that these marks should be obliterated, especially in persons of strumous diathesis or who present a history establishing a tendency to malignancy.

Cases have been reported in which numerous nevi were found at the same time with melanotic sarcomata (Jablokoff), and nevi themselves may develop into malignant tumors, especially after the influence of any external irritation (Benzler).

While it may be purely coincidental, the author has observed that, in nearly every case of malignant disease he has treated, the patient exhibited a more or less extensive growth of nevi, and, in numbers of cases of small nevi about the face that remained entirely benign for several years, finally developed into epithelioma.

For purposes of convenience with reference to treatment we will divide the cases into three groups, according to age, viz: infancy, youth and maturity, and for further convenience subdivide these as to character of lesion, viz: those that are elevated and those that are not.

According to Hager and other eminent authorities, these marks are due to an overgrowth or overstimulation of the part, and although they are generally considered congenital, they are not always apparent at birth, or, if they do so appear, they are usually so small as to oftentimes escape detection, commencing with a spot not larger than the head of a pin, but increasing in size as the child grows, until they oftentimes cover the greater portion of the face.

The reasons, then, for the early removal of these blemishes will become apparent, because we can well understand that the same process that will remove them in the infant will have little effect upon the mature person. We will, then, consider first the best methods to be employed in the first category—the infant.

These blemishes come distinctly under the head of benign growths, and the chief characteristic of such growths is, that when their nourishment is interfered with they retrograde. They are rich in nourishment, having nerves and vascularity galore, and when the supply is interfered with or shut off they die, as it were, of anemia. Pressure alone will do this, but as it is both inexpedient and unsatisfactory to employ compresses on a child so young, we have to devise some other means. So the writer directs the mother to paint the spot daily with a solution of ichthyol in good, strong *contractile* collodion. This may have to be kept up for several months, but the reward comes when the mark entirely disappears. While this process works admirably when the mark is not elevated, it is not so successful in the raised variety, for which the writer uses the following process:

The child is put to sleep and a well wetted pad, the size of the hand, is placed upon the abdomen and attached to the positive terminal of a galvanic battery. To the cathode is attached a short needle holder, in which is fastened a suitable needle—generally a long, slim one, from which the temper has been drawn. After the seat of operation has been cleansed and the needle drawn through an alcohol flame, it is passed *almost* through the mark superficially and parallel with the epidermis. The amount of current employed depends upon the distance the needle has been inserted, but usually is from ½ to 8 milliamperes, which is maintained until the usual blanched appearance indicative of decomposition is obtained. In like manner we attack every portion that is red, introducing the needle as many times as is necessary for the purpose.

The part is now dusted with boric acid, or other dry antiseptic, and in about a week a dark crust will cover the whole area. This should not be disturbed until it is almost ready to drop off.

If the mark has not been very large, the resultant scar will be almost entirely absorbed in a few months, and even where the surface operated upon has been considerable, the scar will not be very noticeable in a year, because, it must be remembered, that the caustic action of the negative pole is very similar to that of any of the alkaline caustics, leaving a soft, pliable ciccatrix that is easily absorbed.

Passing now to the second group—youth—it must be borne in mind that the lesion is not only of greater area, but has also involved the deeper structures, and while it may be removed by the needle as described above, the resultant scar is much more dense and not likely to be entirely absorbed. If the mark is not elevated, it is best to employ the following method, which has proven very satisfactory in the hands of the writer:

℞—Antim. Tart.	1 part
Soap Plaster	3 parts
M. Green Soap	1 part

This is spread thickly—1-12 inch—on adhesive plaster, leaving an adhesive edge to facilitate holding it in place. Being placed upon the mark, it is pressed down firmly to insure good and even contact. It must then be frequently examined, and just as soon as active escharotic effects are evident—which is from three to five days—the plaster must be removed and the surface dressed with

Zinci Oxid.	grs. xx
Cold Cream	drs. iv

When the surface is healed the mother mark will have disappeared.

This brings us to the third class, in grown persons, when the mark has still further involved the deeper structures, and making its removal much more difficult. In this class we employ the X-Ray, and while the experience of the writer has been limited to two cases, the results in these cases have been all that could be desired. We have also been reliably informed that the X-Ray has been successfully employed for this purpose in a clinic in New York City, and while the writer does not claim priority, he had never heard of its being used for this purpose before the treatment of his first case.

If—as has been stated by eminent dermatologists—these marks are due to an overgrowth or overstimulation of the part, and if—as we know—the X-Ray sets up some necrotic process in the underlying tissues, then we can see a strong indication for its use.

In making exposures of these marks to the X-Ray, the writer always uses a mask of sheet lead, cutting out a window the proper size and using a medium low tube at a distance of eight inches. The first treatments are given daily from three to five minutes' duration. After the tolerance of the patient is established the time is gradually lengthened to eight minutes and the sittings suspended as soon as an irritation is produced, to be resumed in about one week as before if the irritation has subsided.

CHLOASMA OR LIVER SPOTS.

Although commonly called "liver spots"—which would naturally induce the belief that the direct cause was in the liver—the proximate cause is altogether unknown.

Ziemssen asserts that they are really connected in some manner with the functions of the genital apparatus, and has noticed that in women suffering from some uterine diseases and affected with chloasma, with the recovery from the former trouble, the latter likewise disappears. The experience of the writer, however, seems to partially at least, disprove this assertion because he has treated a number of cases that were either congenital, or appeared at such an early period in life as to almost preclude the possibility of uterine or genital disturbance.

In removing these blemishes the writer has been quite successful by the use of a French process termed "ecorchement." This has been employed in the hospital St. Louis, Paris, for some years for the removal of chloasma, acne and like skin lesions, and, many of my readers will be glad to learn, is almost a certain specific for chronic eczema.

As this process has heretofore been a well-guarded secret and therefore not known to most of the profession, it is here given in full.

The treatment is divided into two parts, the first acting as a dry escharotic, destroying the epidermis together with the pigment underlying, which is replaced by a soft and pliable new one that is without blemish. It takes about ten days, does not destroy the hair when applied to the margin of the scalp and leaves no scar.

The first part of the process is as follows:

℞—	Resorcin	40	parts
	Zinci Oxid C. P.	10	“
	Acid Salicylic	2	“
	Lard	20	“
M.	Olive Oil	8	“

As the writer can trace many poor results to the careless compounding of this prescription, he wishes to urge upon those who would give it a trial, the importance of the intimate intermingling of the ingredients. Rub up the resorcin in the mortar until all the crystals are thoroughly broken down, mix well with the salicylic acid and zinc oxide and *do not* substitute vaselin for the lard.

This is rubbed on the part to be treated twice a day until the skin assumes a cracked and dry appearance just as if chapped, which generally takes four or five days, then the part is carefully washed with a sponge and soap to remove any residue of the ointment and, after being thoroughly dried, is ready for the second part of the process.

This consists of a paste very similar to our old surgical glue and, as the writer has always prepared it extemporaneously, the quantity of ingredients here given is only approximate:

℞—	White Gelatine	ozs. iv
	Zinci Oxid,	drs. ii
	Glycerine	gtts. xv
M.	Aqua Bullient	q. s.

This should be prepared on a water bath by first adding sufficient water to dissolve the gelatine, then stir in the other ingredients. It is applied hot, using for this purpose an ordinary paint brush. Before this has had time to dry it should be covered with a sheet of absorbent lint and another coat of gelatine paste applied over the lint.

In two or three days this mask becomes loose around the edges and may be removed—the dried skin together with all discolorations coming off with it.

CHAPTER XXXI.

STATIC ELECTRICITY IN CHRONIC NEPHRITIS.

Original investigation, especially upon medical subjects, and where the results are almost phenomenal, is almost necessarily fatal to the finances and reputation of the investigator unless he be spared long enough to gain the company of sufficient support to strengthen his position.

How prone is the physician to criticize adversely the things that are new, and how inexplicable is human nature in general in this respect. The writer was forcibly reminded of this seemingly innate characteristic of all mankind when, eight years ago, he had the temerity to attack the old, accepted pathology of a recognized incurable lesion—chronic Bright's disease. And how nearly fatal it proved to his medical aspirations until, by persistent and extended clinical work, the dark clouds of adverse criticism are being replaced by the sunshine of honest investigation. Many letters are constantly being received stating the experience of other physicians in this direction and going further to prove the views of the writer.

Let us look for a moment into how static electricity does its work. There is no one today who would doubt, after the elaborate and conclusive experiments of Schiff, Dubois-Raymond, d'Arsonval and others, that we have electrical currents traversing the body in every direction, and that the nerves are the carriers of these currents. It is also true, as has been stated elsewhere in this work, that everything that acts as a carrier of an electrical current vibrates.

The molecules of a copper wire become so disturbed by the vibration of an electrical current that in time it may be broken like a piece of cast iron. Then, it is manifest that if the nerves carry currents of electricity they must vibrate, and in the state of perfect health the nerves are constantly vibrating. Each nerve vibrates in a different way from every other nerve because they all carry different kinds of currents. The rate of vibration is peculiar to the kind of current carried by the nerve. Whenever a nerve loses its normal vibratory tone its function is destroyed and degenerative changes occur. The patient on the platform of the static machine is subjected to a rate of vibrations, from a few to many millions per second, so that every nerve in the body will find a rate to which it will respond, and they will vibrate normally. If a nerve is not vibrating normally, it will choose its vibratory tone from the currents generated by the static machine and vibrate in a normal way. Every nerve in the body is taking the vibrations which are peculiar to it and they are normal for the time being. Of course, if degenerative changes have taken place in the nerve, so that there is no longer any substance to act as a carrier for the current, the nerve will not vibrate. It is dead.

We have many beautiful illustrations of this fact, and recall very vividly one case, that of a man who fell from a street car and injured the nerve that supplies the left internal rectus muscle of the eye. In consequence of this injury he had diplopia or double vision. When we held up a ball before him, before the machine was in action, he always saw two balls, one about four or five inches above the other and a few inches to one side. Then when the machine was started he would, after five or ten minutes, see only one ball. The reason for this was that the vibratory action of the current had conveyed the proper vibrations to the injured nerve in the muscle and for the time being, at least, that nerve was functionating properly and his vision was normal. As soon as the machine was stopped he again saw two balls.

Static electricity is an equalizer of the nervous forces. It will temporarily reduce a high temperature, or it will elevate a low or subnormal temperature. It will reduce a high pulse or raise a low pulse. You can also see the good effects of static electricity in the increased elimination of the waste products, such as urea, CO_2, sweat, etc.

Take a patient suffering from poor circulation, having cold feet and hands. Include him in the static circuit and in a little while his feet and hands are warm and he is perspiring. What does it? Simply an equalization of the nervous forces, and what seems to be the most pleasant of all forms of electrical treatments is the most far-reaching in its effects.

Every day brings evidence that convinces the author more firmly than ever that chronic nephritis is a disease of central nervous impairment. The natural paths along which impressions are conveyed to the kidney are the splanchnics and the spinal cord, and whenever this nervous tract is impaired the function of the kidney is correspondingly affected.

Bernard, in his experiments on animals, says that by irritating a certain portion of the floor of the fourth ventricle he could produce albumin in the urine of the animal. Other investigators have, by similar means, succeeded in producing diabetic sugar.

The author was forced to the conclusion of the nervous origin of this disease by the character of the persons afflicted. We rarely find a hard-working man of the laboring classes having this trouble, but it is people who use their brains, those who have mental worry—doctors, lawyers and preachers—in other words, it is the people who press the button that rings up the great sympathetic until the battery which runs it is exhausted. Grief alone has been known to produce Bright's disease. How could grief produce Bright's disease if it were not through central nervous channels?

It is said that there is a balm for every ill, and there is more than a grain of truth in that saying. It forces us to the conclusion that no disease should be looked upon as incurable. Nature has given us a remedy for every disease, and it is our duty to find out just what that remedy is. Chronic Bright's disease has long been looked upon as incurable, and yet it seems to be very tractable, indeed.

It was the intention to present in this chapter the reports of twenty consecutive cases, in which the diagnosis was made by experts, but on account of the length and similarity of these reports it is only deemed advisable to present a few typical cases and give a general summary of the whole.

The first case, treated fifteen years ago, was not only a typical one, but the diagnosis is undoubted, being made by no less an authority than Dr. Edwin Klebs. He came to Chicago to attend a course at the Post Graduate medical school and incidentally to seek advice for his trouble.

He said that he had no objection to our trying the treatment, but informed us very positively that he had absolutely no confidence in electricity. So in that particular case we could not ascribe any beneficial effects that might accrue from the treatments with static electricity to any psychical effect.

The urine contained over 50%. albumin by volume and both hyaline and granular casts. He also had albuminuric retinitis to such an extent that his vision was seriously impaired. I gave the doctor sixteen treatments in all, the least number of treatments I have ever given in any case. He went back home into active practice, something he never expected to do, and is entirely well today.

Case II. Miss H. A., 23, referred for treatment by a prominent physician of Iowa. Had albumin in urine since the age of 18. Analysis showed sixty-four grains to the liter, numerous casts, both hyaline and waxy. Although large of frame, she was anemic and yellow and so weak it was with the greatest difficulty she was brought to the office for the first few treatments. Weight 92 pounds. Ankles swollen. Heart's action fairly good.

After the third treatment she was able to come to the office unassisted, and in two weeks could walk five or six blocks for her daily exercise. In three weeks she menstruated normally—the first time in six months. At the end of the fifth week she returned home, her urine showing no trace of albumin and no casts. Her father came into the office six months afterward and said she weighed 132 pounds, and was doing all the household work. One year afterward she married and has had no return in 12 years.

Case III. This case is cited both on account of its typical character and the fact that the diagnosis is unquestioned, having been made by a prominent physician of Philadelphia with more than a national reputation in diseases of the kidney. The patient had chronic albuminaria for six years and had been treated by the above mentioned physician for four years. His treatment by the writer was commenced in April, 1902, and continued for seven weeks, at which time there was not a trace of albumin and no casts. He has lately been accepted by the New York Life Insurance Co. for a $5,000 policy. He was examined by their local physician, as well as by the company's physician in New York, and gave both a full history of his condition for the last six years, and they found him sound and well.

There is no mistaking the diagnosis in such a case, because it was made by a man with a world-wide reputation in that particular field. And the fact that in spite of his previous condition he was accepted by an insurance company for a large policy would tend to convince the most skeptical that the treatment he had received was directly responsible for his condition.

None of the cases have been strictly dieted. They need good, nourishing, digestible food. The lessened amount of albumin excreted under strict diet has no clinical significance.

The author may be criticized for not giving "hair-splitting" descriptions of the various forms of nephritis, but the *results* of his treatment in *all* varieties will be his excuse for considering all cases under the general name of "Chronic Bright's Disease."

Dr. Hurd, in a recent article, aptly defines the author's position in this respect as follows: *"There is no regular correspondence* between the gross appearance of the kidneys and the *clinical symptoms,"* and, further, the same writer says, "it is easy to divide these kidneys, according to their anatomical changes, into a number of fairly marked classes, but as this division *does not* correspond to clinical divisions, it is valueless for clinical purposes."

A few points, borne out by the author's experience, may serve as a reminder.

Chronic nephritis is more essentially a disease of central nervous impairment. One of the strongest proofs of this is the kind of persons afflicted.

The natural paths along which impressions are conveyed to the kidneys are through the splanchnics and spinal cord; and when these tracts are impaired, the function of the kidney is correspondingly affected.

The results of decapsulation show it not to have a place in the successful treatment of this disease, and other operative procedures have been equally barren of results.

The reduction of albumin obtained by strict diet has no clinical significance.

The remedy indicated is one that will hasten the oxydization of waste products.

Static electricity is the logical remedy, because the evolution of oxygen, always accompanying this modality, not only hastens the elimination of waste matter, but gives a better tone, by its vibratory action, to the nerve centers affected. Static electricity is a powerful equalizer of the nervous forces, as is evidenced by its effect on the temperature, respiration and pulse.

In all cases of chronic nephritis treated by the author, where there was mitral regurgitation or the hypertrophy which precedes it, the results have been almost entirely negative.

The summary of twenty consecutive cases, in which the diagnosis is unquestionable, is as follows:

Permanently relieved........	12, or 60%
Partially relieved...........	2, or 10%
Failures	6, or 30%

The two cases that were partially relieved were still taking treatment and showing some improvement, but were finally lost sight of.

Although the results in 30% were finally negative, two of the cases were so materially benefited after one month's treatment that they were provisionally discharged. Both returned after the lapse of one year as bad as when first seen, and were not benefited by subsequent treatment.

In all the unfavorable cases the heart's action was characteristic of the advanced stages of the disease. Two had passed the age of 70, one was only 15.

Longest time between the discovery of the disease and presentation for treatment in all cases was six years.

Of the twenty cases, seventeen were males, three females.

Five were physicians; four board of trade operators; three preachers; two housewives; one domestic; two traveling salesmen; one clerk in city hall; one jeweler; one laborer.

The treatment used in most cases has been the negative head breeze for fifteen minutes, followed by positive insulation for the same time. The Morton Wave current to spine is alternately substituted for the head breeze.

Treatments are given daily. After a few sittings the urea commences to increase, carbon dioxide is eliminated and albumin and casts decrease. The patient has a feeling of well-being, sleeps well and is free from pain.

For directions for arrangement of machine and patient in giving these treatments the reader is referred to page 66.

Since this chapter was written and printed in the seventeenth edition, the author has changed his technique somewhat by substituting for the static insulation the auto-condensation obtained from a powerful high frequency apparatus. This is especially indicated when the blood pressure is very high.

As this process is elaborated in another part of this work, the reader is referred to same.

CHAPTER XXXII.

OZONE AS A THERAPEUTIC AGENT.

Ozone is in reality the "world builder" and has more to do with the phenomenon of life than any other one agent It has everything to do with metabolism, both destructive and constructive, and without metabolism life must cease. Much of the therapeutic value of electric currents applied to the body depends upon the generation of this agent. All currents produce it in different degrees, but the greater the frequency and the higher the voltage the greater its production.

The ozone in the atmosphere has the property of acting as a stimulant without injurious action, but is not of sufficient strength to overcome disease except in the incipient stage. The ozone generated artificially is usually so mixed with nitrous gases and oxides as to make it absolutely injurious when inhaled. This is especially true of the product produced by the employment of very high tension currents where a spark gap is maintained.

The static machine has been almost universally used in the past for the generating of ozone for therapeutic purposes, but on account of the high tension properties of this current the ozone generated contained such an admixture of noxious gases as to render it entirely unfit for inhalation.

Many valuable improvements have been made lately in ozone generators, principally with the view of eliminating the nitrous gases. The apparatus used by the author, shown in Fig. 37, differs from all the others, in that the oxygen of the air is converted into ozone by a convective or brush discharge from a high potential transformer, thus furnishing a product reasonably free from noxious fumes. The ozone thus set free is purified by being conveyed through hard rubber tubes into cups containing balsamic oils, through which it filters, afterwards passing out, in a perfectly pure state, through hard rubber tubes to the inhaling masks.

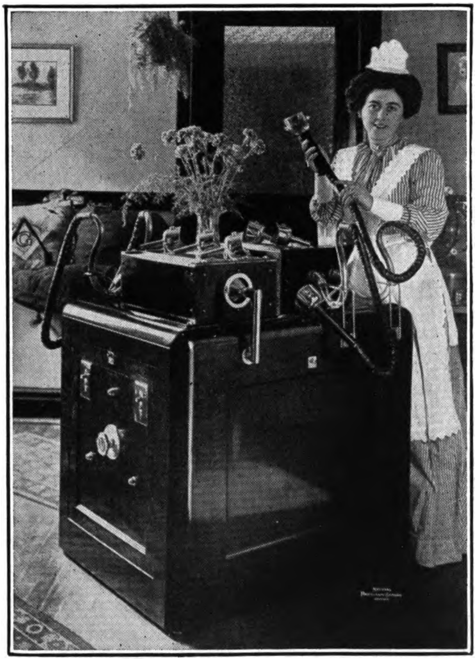


FIG. 37.

The transformation of current is accomplished in a similar manner to that described on page 264, where the ordinary alternating current of 100 volts is raised to one of many thousand volts by being passed into the primary winding of a high potential transformer.

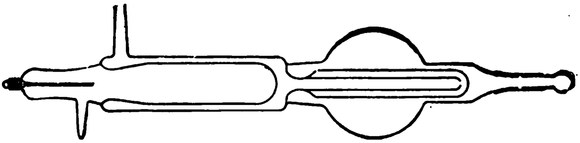
As it is only possible to transform alternating currents, it becomes necessary, when only the direct current is obtainable, to place within the cabinet a rotary converter by which the direct is changed into the more desirable alternating form. The apparatus is simple in construction and not easy to get out of order.

Ozone acts as a powerful antiseptic in contact with diseased mucous surfaces, consequently its beneficial action is quickly apparent in the treatment of bronchial and laryngeal affections, catarrh, hay fever and all diseases of the respiratory organs. When inhaled it hastens the oxidation of the blood, increases the red blood corpuscles and, by producing a feeling of well being in the patient is of the greatest value in neurasthenia, melancholia, hysteria, psychologic impotence and other neuroses.

No absolute rule can be given regarding the length of time treatment should be given, as every case is a "law unto itself."

Usually from fifteen minutes to a half hour is sufficient, and the flow of gas should be so regulated by the rheostat and stop cocks that coughing or other unpleasant symptoms be avoided.

The balsamic oils, after being used for some time to purify the ozone, make an excellent dressing in skin diseases and indolent ulcers.



Ozone Inhaler to Be Used on Any High Frequency Current

CHAPTER XXXIII.

THE REMOVAL OF SUPERFLUOUS HAIR.

The physician, as a rule, does not do enough cosmetic work, but is too apt to relegate it to some *facial artist* who is totally unfitted.

How many times do we hear the complaint, "I have had the hair removed from my face several times, but it always comes back worse than ever." There need be no such complaint if the operator understands the proper manipulation of his current and instruments, because there is no surer way of destroying a hair follicle than by electrolysis.

In this operation, as in most others, success mainly depends upon the instruments employed. We cannot do good work without good tools. If we have properly shaped needles, good forceps, a suitable magnifying glass, good light and understand the handling of our current, the work becomes a pleasure, and success is assured.

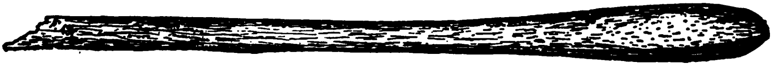


FIG. 38.

The "Hayes bulbous-pointed needle," a magnified drawing of which is shown in Fig. 38, was devised by the late Dr. P. S. Hayes and is best adapted for this work for several reasons.

A scar left in destroying a hair by electrolysis, or, in fact, any blemish, is the result of producing decomposition of the epidermis, and if this is avoided, scar tissue would never be made.

It is a well-known fact that the most electrical energy is expended at the point of best contact, because that point is the one of least resistance. It can readily be seen that in using the bulbous-pointed needle the point of best contact is in the bottom of the hair follicle—just where we want it, but if we would use a sharp-pointed needle, the point of best contact is in the epidermis, where the most decomposition would take place, and a scar would be the result. It would also be evident that such hair follicle would not be destroyed, because nearly all the electrical energy has been expended *at the surface.*

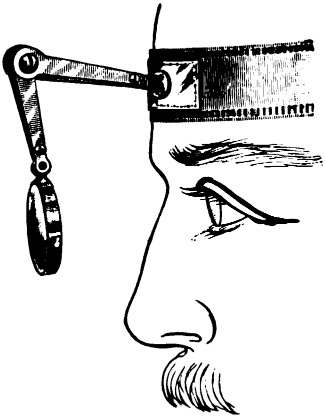


FIG. 39.

The magnifying glass mounted on a head band—shown in Fig. 39, is a necessary part of the armamentarium, because no one, be their eyesight ever so good, can do as successful work without it. The glass should have a focal distance of about five inches, so as to allow of plenty of working space between the seat of operation and the glass.

The forceps should be of steel—light and strong—the inner aspect smooth and in good, even contact.

The indifferent electrode (Fig. 40) is about the size of the palm of the hand.

A short needle-holder (Fig. 27) is best adapted for the purpose, especially when removing hairs under the chin, and the distal end should be sufficiently pointed so as not to obstruct the view of the operator.

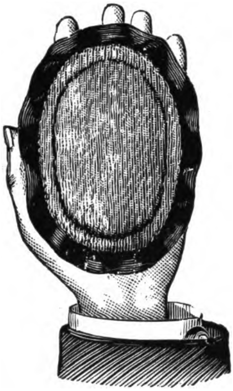


FIG. 40

The patient should be placed *flat on the back* on the operating table, with the head level with the body, and the indifferent electrode, after being well wetted, is placed on the pectoral muscle in front or on the upper border of the trapezius behind. The patient should never be allowed to hold this electrode in the hand or otherwise have control of it, because they soon learn that by making light pressure the needle does not hurt, and incidentally the operator is doing poor work.

The needle-holder, being fastened to a light conducting cord, is attached to the negative pole of a galvanic battery. The needle is now carefully introduced into a hair follicle, following the direction of the hair shaft, and the current turned on by means of the rheostat until ¾ milliampere is reached.

Hydrogen froth will commence to come out around the needle, and in some works this is stated as evidence that the follicle is destroyed, but it is not the case. The length of time the needle must remain in the follicle depends upon the character of the hair and the strength of current employed, and can only be learned by experience. The hair is destroyed when it comes out without traction.

After the current strength has been once established it should not be turned off, but the needle introduced into successive hairs *with the current on.* It is no more disagreeable to the patient to operate in this way than to introduce the needle and then turn on the current, and, besides, saves much time and inconvenience. It also makes more rapid work to operate on four or five hairs before picking up the forceps to remove them.

Wherever a hair is removed a little vesicle appears, and if too many are operated upon in close proximity these little vesicles will become confluent and make a sore. It is always best to press out these little blisters, using for this purpose a piece of absorbent cotton, then wash the part with boric acid solution.

Less current may be used on the upper lip than on other parts of the face; first, because the hairs do not grow so deep, and, second, because in that location the pain is greater.

A good operator may remove one hundred hairs in an hour and not have over 5% return.

MOLES.

There are several things about moles that do not seem to be well understood by the medical profession, consequently the laity suffer from lack of advice, or poor advice on the subject.

A press dispatch from Paris recently appeared in the daily papers, stating that the Academy of Medicine advised against the removal of these growths, as such operation "might produce a cancer." It is just such statements as this that are misleading because they do not tell the whole truth, and are liable to do much harm.

The tendency to have a malignant growth—a cancer—is not an acquired tendency, but an innate tendency, acquired by inheritance. It is not at all necessary that your patient give a history of cancer in the immediate family to establish this malignant tendency, as any strumous or tuberculous conditions are sometimes amply sufficient.

A lady came to consult me recently about a well developed carcinoma of the breast. She laughed when I began asking her about her antecedents, and remarked, "I have had all those questions asked me before. You are trying to ascertain whether there has been any cancers in our family. There never has been." I said to her, "Is your mother living?" She replied, "No; mother died when I was a child." "Of what did she die?" I asked. "Consumption," was the reply. "This growth on my breast came from striking it against the corner of the bureau."

Here was a patient who had an inborn tendency to have a malignancy, and all that was necessary was an exciting cause to bring it about. She might have lived to be an old woman but for the injury caused by striking the bureau.

Some persons fall, and the result is a cancer. Other persons may fall and hurt themselves much worse and yet never have the cancer, because they did not have this inherent tendency.

Now, it is true that the removal of a mole might be sufficient cause for the production of a cancer, more especially if the mole be removed by the knife or acids, and the patient has the inherent tendency, but it is also true that the presence of the mole, especially about the face, is a constant source of danger. A cancer is caused by constant or repeated irritation of degenerate cells, and the mole being in such location as to be repeatedly injured, the result is evident; in fact, I believe I never treated an epithelioma about the face that did not come from a degenerated mole.

Our own Dr. Nicholas Senn was a great stickler for the removal of these blemishes as early in life as possible, because in early life, up to the age of 40, the tissues have more resistance and no trouble will ensue from the removal of the growth, while if left alone it is almost sure to ultimately cause serious trouble.

A great deal depends upon how the growth is removed. The knife, acids and cautery produce much irritation and invariably leave a scar. From an experience covering many years, I believe that negative galvanism gives the best results and is devoid of the dangers of other measures. The growth turns black and comes off in a few days as a crust, leaving only a red spot that entirely disappears in a few weeks. There is practically no limit to the size of the benign growth that may be removed by this method, but it is my practice invariably to remove the growth at a single sitting. If the mole is hairy, remove the hairs by negative galvanism first, as the removal of the hairs will destroy the greater part of the growth, while the removal of the growth will not destroy the hairs.

The question now arises: If these growths are allowed to remain until middle life, or even old age, when the tissues have almost entirely lost their resistance, will their removal cause sufficient irritation to produce a cancer, in persons who have the inherent tendency? In an experience of over twenty-five years of removing moles by the process I have mentioned I have had only two cases in which an epithelioma resulted, and in both these cases the growth was not entirely removed at a single sitting, as I have advised, but was kept in a constant state of irritation by repeated operations. Both of these cases, however, were eventually cured with the X-ray. On the other hand, I have treated a number of epitheliomas that were caused by the removal of moles with the knife or caustics.

I believe the physician should tell his patients of their tendency to have a malignancy so that avoidable accidents may be guarded against. It is well also to advise the removal of moles or other benign growths that may be about the mouth, nose, eyes or breast. There may be many patients who have a cancer whose family history is negative as to the tendency to have cancer, but one thing I have noticed that is not of record. *A growth of moles indicates a tendency to malignancy.* In fact, I have rarely treated a patient for a malignant growth that did not have a number of moles. While the existence of moles in relation to a malignant growth might be purely coincidental, it is hardly probable that they could be so universally associated without good grounds for the assertion I have made.

Technic.—In this, as in all operations, requiring decomposition of tissue, the negative is used for the active pole, because its action is much the same as an alkaline caustic. The introduction of a needle, attached to the negative pole of a galvanic battery, into a mole, is not essentially different than the injection of a fraction of a drop of caustic soda or potash into the growth.

Into a needle holder, as is shown in Fig. 27, is inserted an ordinary half-curved surgeon's needle, small size being preferred. The indifferent or positive electrode is a pad such as is shown in Fig. 40, which, after being well wetted, and placed on that pole is applied to the body at some convenient place. The needle, which should always be attached to the negative pole, is inserted into the growth at the base on a line with the skin, not quite through, but nearly so. The current is now gradually turned on until a very small amount is reached, probably ½ milliampere, when, in a little while, the current can be gradually increased up to 5 milliamperes if desired without causing any great pain. The fact must be borne in mind that the longer the current is flowing, the less will be the pain. This is no doubt caused by the tissue becoming dead on account of the active decomposition taking place along the course of the needle.

A sign of decomposition in the removal of these growths is the color we get. The growth will commence to blanch slightly as soon as the current begins to flow, and just as soon as the entire growth has assumed a decidedly blanched appearance, we know that electrolysis of the contents has taken place, and that in a few days it will turn black and come off as a crust. If the entire growth is not blanched by introducing the needle one way, it will be necessary to introduce it again at the same sitting, in a crucial direction. Always destroy a growth at one sitting unless it is quite large.

The scar left after removal of warts and moles will be insignificant and be gradually absorbed, but when removing them about the face for purely cosmetic purposes, it is best to insulate the needle with shellac varnish to within a small space at the distal end. In this way we avoid electrolysis of the epidermis at the point of entrance of the needle, which always makes a small scar.

The same technic here given for warts and moles answers for all benign growths.

CHAPTER XXXIV.

GOITER. IDIOPATHIC AND EXOPHTHALMIC.

Idiopathic or simple goiter has been treated by electricity with varying success for a period covering many years, but since the advent of cataphoresis results have been much more uniformly good.

Negative galvanism and iodin are both indicated remedies in the treatment of an enlarged thyroid gland, and as iodin is *repelled* by the negative pole (see page 36), we have excellent opportunity of using both remedies at the same time. The effect of the negative pole is to soften, liquefy and disintegrate tissue, while the iodin acts as a resolvent. When iodin is to be used for cataphoric application it is best to use a solution of potassium iodide—about one dram to the ounce—as this solution is a much better conductor than any of the iodin solutions, and contains sufficient iodin for all purposes. If a solution of iodin is used it should be one-fourth Lugol's solution to three-fourths water. Alcoholic tincture of iodin cannot be diluted except with alcohol and should never be employed for this purpose, on account of the great resistance of the alcohol.

A good technique that has been quite successful in my hands is as follows:

I always place the patient on the operating table in a recumbent position. This is done for the double reason that the electrode on the neck is easier kept in position, and because the very best place for the indifferent or positive electrode is on the abdomen. In most cases there will be no objection regarding putting the indifferent electrode at this point, but if there should be, as in cases of young girls, I am accustomed to allow the patient to place the electrode herself, after first having thoroughly wetted the same and placed the cord tip in its receptacle.

I am not unmindful of the fact that many operators treat the patient sitting on a chair, with one electrode held over the gland and the other on the upper dorsal or lower cervical spine, but by placing the electrodes as I have outlined they do not have to be held by the operator or patient, and the former can give his undivided attention to the battery.

For the neck, the author uses a pad about ½ inch thick, somewhat the shape of a half moon and backed by a piece of copper mesh, sewed onto the pad. A piece of tape is sewed to each end. To one end is fastened an ordinary hook and to the other end "eyes" are sewed on about ½ inch apart, so that the electrode can be made to fit any sized neck. All my pad electrodes, large and small, are now backed by this copper mesh—the same as used for window screens. It is much cheaper and lasts longer than block tin.

This pad is now well moistened with a 2% solution of Churchill's iodine, and fastened over the goiter by means of the "hook and eyes," and attached to the cathode of a constant current. The anode is the usual abdominal pad.

The current is turned on gradually until 20 milliamperes is reached, which should be maintained for ten minutes, and repeated as often as the irritation caused to the skin will permit. This would probably be about 3 or 4 times per week, but in dark complexions with thick skin I have oftentimes applied it daily without inconvenience.

EXOPHTHALMIC GOITER.

On account of adversely influencing the vagus, I have long since ceased to treat Graves' disease with the constant current, although Osler recommends that galvanism should be given a thorough trial for three or four months in every case. Rockwell and James Lloyd also report good results from the use of galvanism. I have used the X-ray *in the old way* with high frequency tubes, coil tubes and transformer tubes on a multitude of cases, and accomplished nothing but burning the skin in most cases until I began using the deep therapy with Coolidge tube, and technic as stated hereafter.

M. K. Fischer (N. Y. M. J.) advocates the Roentgen treatment and prefers frequently repeated and small doses. He reports that the symptoms are relieved in the following order: exophthalmos, nervousness, dyspnea and lastly the tachycardia. The thyroid may or may not return to its normal size.

These results were much the same as those obtained by the author that far back—1915—except that a number of burns resulted from the frequently repeated doses.

Sinosersky (Semaine Medicale) is reported to have excellent results from irradiation, but only in those cases in which the presence of distinct thymus gland was demonstrated by percussion, radiography and blood examination.

The exposures were of ten minutes each, every fourth day, the dose being 4 H. through 2 mm. aluminum. After a series of exposures, treatment was stopped for three weeks on account of sensitiveness of the skin. After fifteen to thirty exposures the gland was diminished about 2 cm., and the heart beat dropped from 120 to 80 per minute.

It seems to be the consensus of opinion among foremost surgeons that an enlarged thymus gland is a dangerous and frequent complication of Graves' disease.

Simpson (Medical Record) says he is unable, at this time, to state the frequency with which cases of exophthalmic goiter are associated with enlarged thymus glands, but concludes the percentage must be considerable.

If such an association exists—as is shown by Cretti and Ledoux—it offers no serious objection to Roentgen therapy, as both glands, being very radio-sensitive, may be exposed at the same time.

He concludes that if the future proves that such a close connection exists between exophthalmic goiter and hyperplastic thymus glands, it is evident that it will tremendously hinder surgical interference, while not in the least discouraging Roentgen therapy.

F. A. Stoner claims to have had one failure in forty-one cases. Ladoux had equally good results.

Schultz has produced complete atrophy of the thyroid gland and concludes that it is the most radio-sensitive organ in the body.

Pfahler has obtained marked improvement in 75% of his cases of exophthalmic goiter.

In treating these patients by deep Roentgen therapy, the fact must not be lost sight of that massive doses must be given, at the same time protecting the skin from injury. Too much attention, therefore, cannot be given to the matter of filters. I use 4 mm. aluminum and one thickness of sole leather, and cross fire through two lateral openings in sheet lead 1/8 inch thick, using 4 H through each opening, or a complete dosage of 8 Hampson.

CHAPTER XXXV.

HIGH FREQUENCY CURRENTS.

Rudimentary Physics.

Over twenty years ago Nikola Tesla, in an historic lecture before the American Institute of Electrical Engineers, called attention to the wonderful and peculiar properties of alternating currents of high potential and great frequency. His spectacular experiments attracted world wide attention, so much so indeed that since that time the terms "high frequency currents" and "Tesla currents" are often used synonymously. Tesla called attention to the fact that electricity in this peculiar form might prove valuable in the treatment of disease but it remained for later inventors to produce a commercially practical apparatus for the physician's use. The earlier models were necessarily somewhat crude but the efforts of inventors and manufacturers have combined in producing high frequency apparati which are far more reliable for general treatment and X-Ray production than any other similar appliance in the physician's armamentarium. The modern high frequency apparatus is truly remarkable in its simplicity, reliability and range of usefulness.

In this chapter we shall treat the subject of high frequency currents purely from a physical standpoint, laying particular stress upon those points of special interest to the physician. Omitting, as far as possible, the discussion of the more complex interactions which would only interest the student of pure physics, and make as clear as possible the fundamental principles upon which high frequency phenomena are based.

There are three principal methods used in therapeutics for the generation of high frequency currents, viz., the d'Arsonval, the Oudin, and the Tesla or induction method.

Broadly speaking all high frequency apparatus used in therapeutics is based upon one fundamental principle. In all the varied forms the apparatus may take, they all employ the disruptive discharge of a condenser as a means of causing the current to vibrate or oscillate rapidly to and fro. The fundamental thought, therefore, to bear in mind when first entering the domain of high frequency phenomena, is the oscillatory character of the condenser discharge.

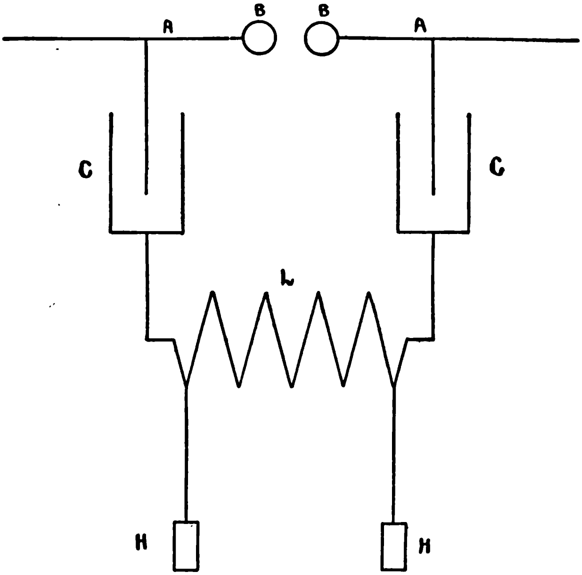


FIG. 1.

The arrangement employed by d'Arsonval is shown diagramatically in Fig. 1. Referring to the figure, A A are the prime conductors of a static machine, or the terminals of an induction coil, to the ends of which are attached the balls B B comprising the spark gap. C C are Leyden jars, the inner coating of which are connected with the conductors A A as shown, while the outer coatings are connected with a solenoid or coil of wire L. H H are handles or other electrodes, by means of which the current is applied to the patient.

Let us assume the terminals A A receive a charge from some source such as a static machine or induction coil. The potential or voltage between the balls B B, commonly called the spark gap, rises until the electric stress between them becomes too great for the intervening air to withstand, and a discharge passes. To the unaided eye this discharge appears to be a single spark, but in reality it is a number of successive sparks or discharges following each other with extreme rapidity. The current across the gap, therefore, is not a single spasmodic discharge, but is composed of a great number of smaller discharges. As a matter of fact it is oscillatory in character, changing its direction perhaps millions of times per second.

Let us illustrate this oscillatory action by employing an hydraulic analogue.

Fig. 2 shows the hydraulic analogy of the electric circuits in Fig. 1, like letters on the drawings indicating, as far as possible, corresponding parts. In the analogue the ether is represented by water, the action of the two fluids—if we may speak of the ether as a fluid—being near enough alike for our purpose. The coatings of the condensers are represented by compartments, the condenser coatings and compartments resembling each other in that they both have capacity and are capable of storing up under pressure of the acting fluid. The dielectric or insulating material separating the condenser plates is represented in the analogue by elastic diaphragms. When electric pressure is applied to a condenser the ether and dielectric separating the plates is put under stress. Similarly when hydraulic pressure is brought to bear upon the compartments of the analogue, the elastic diaphragms separating the compartments are strained. In Fig. 2 the system of piping corresponds to the system of conductors in Fig. 1, each serving the purpose of a path for the exciting fluid. In the electric circuits the source of potential energy is the static machine or induction coil, while in the hydraulic analogy this energy is derived from the movement of two pistons P P exerting a pressure on the water. The similarity of the operations is obvious.

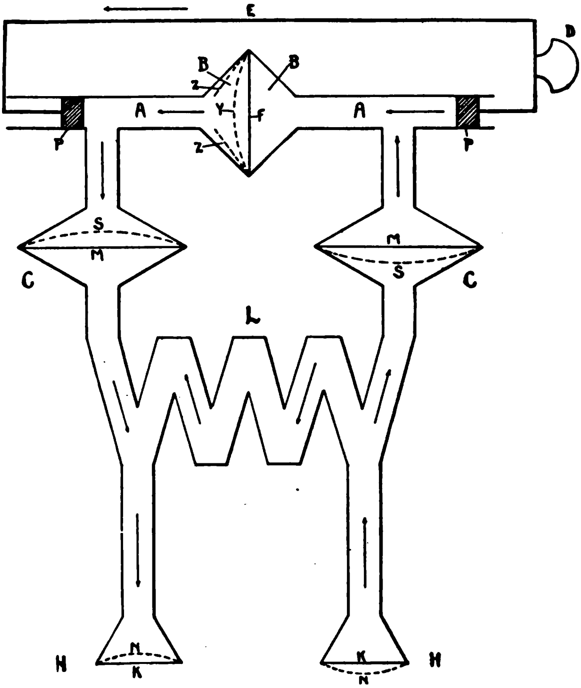


FIG. 2.

In Fig. 2 the coil of pipe L represents the solenoid similarly lettered in Fig. 1, while H H takes the place of the electrodes, and comprise funnel shaped compartments over the mouths of which are stretched elastic diaphragms. In the matter of the spark gap we shall have to ask the reader to draw upon his imagination. In the hydraulic model the balls of the spark gap are represented by compartments B B, and the air separating the balls by the elastic diaphragm F. Unlike the other diaphragms employed, however, imagine this to be readily broken by excessive strain, and to possess the magical property of restoring itself a short time after each rupture. We are now ready to operate our hydraulic model.

Grasp the handle D and move it in the direction shown by the arrow. This handle is connected by a framework E to the pistons P P, which exert a pressure directly upon the water in the pipes A A. This corresponds to the pressure of the electric current. This pressure is communicated to the diaphragms F M and M. which illlustrates the electrostatic pressure exerted upon the air separating the spark gap terminals, and the insulating medium separating the condenser plates respectively. The diaphragms M and M take the position shown dotted by S and S and in so doing communicate the pressure to diaphragms K and K causing them to be strained into the positions N and N.

The diaphragm F during this operation has been forced into the position Y as shown. Now assume that this diaphragm suddenly gives way and breaks down as indicated by the position Z. The water flows suddenly from one compartment to the other, the direction of the movement of the water being represented by the arrows, and the velocity of the water being accelerated by the recovery of the elastic diaphragms to their normal position. The result of this operation is a spasmodic impulse sent along the hydraulic circuits, resulting in a communication of the motion to a patient if he be in contact with the diaphragms K and K of what we may call our hydraulic electrodes H and H. On account of the inertia possessed by the water the diaphragms are carried past their normal position, with the result that another, though weaker impulse, takes place in the opposite direction to the flow indicated by the arrows in Fig. 2. This process continues until the energy is dissipated as heat caused by internal friction of the water against the walls of the pipe, etc.

It is obvious that if the handle D be given a reciprocating motion, and the diaphragm magically restores itself shortly after each rupture, an oscillatory motion of the water will result, which motion may be applied by the devices H H, to a patient. The similarity, therefore, between the electric and hydraulic circuits is evident. In one case the ether is given an oscillatory motion and in the other case the water.

It might be said that we have gone too fully into the details of the above comparison, but when it is remembered that this illustrates the basic principle of high frequency apparatus, the reader will, no doubt, realize that the time has not been wasted.

Currents of extremely high frequency may be generated by employing the disruptive discharge of a condenser utilizing this principle. Prof. Jagodis Chunder Bose produced a current changing its direction 50,000,000,000 times in a single second, which is 10,000 times as rapid as would suffice to impress the retina of the eye, and we would have light directly without the necessity of going through the lower forms of vibration. Bose came within thirteen octaves of producing wave lengths corresponding to the orange light of the spectrum.

CHAPTER XXXVI.

DIFFERENT FORMS OF HIGH FREQUENCY APPARATUS.

On account of the high frequency, d'Arsonval was able to pass through his patients electric currents which at a lower frequency might have proved fatal, but one of the serious disadvantages of the d'Arsonval current is its comparatively low voltage, its potential being limited to that of the current charging the condensers, and controlled by the length of the spark gap.

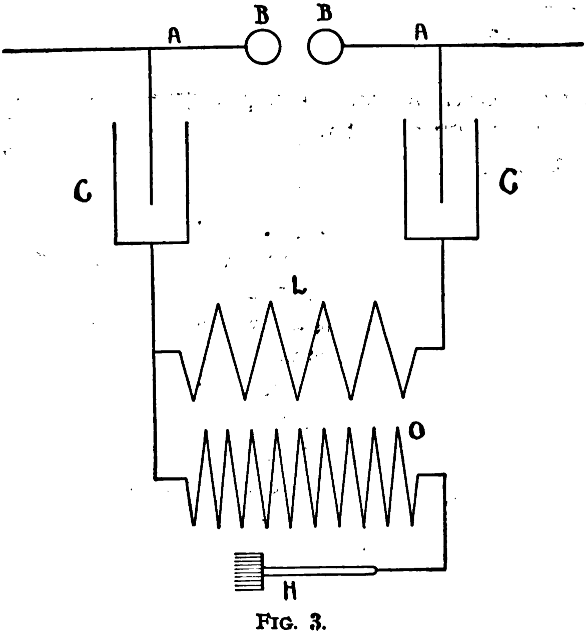


FIG. 3.

Oudin partly overcame this difficulty by adding to the solenoids of d'Arsonval another and larger coil, as shown in Fig. 3. This raised the voltage to such an extent that the brush discharge, or high frequency spray, could be obtained.

Foreign manufacturers brought this type of apparatus to a high degree of perfection, and very satisfactory results were obtained by electro-therapeutists abroad with this method of treatment. Crude forms of Tesla's apparatus were experimented with, but the foreign apparatus most used was constructed on the principles laid down by d'Arsonval and Oudin.

When American manufacturers entered the field they confined themselves almost wholly to the development of high frequency apparatus based upon the Tesla or induction principle. Those who used the methods of d'Arsonval or Oudin copied almost outright foreign makers, and in most cases produced an apparatus of inferior quality.

The Tesla system employs, in place of the solenoids of d'Arsonval and Oudin, a disruptive discharge coil or high frequency transformer consisting of a few turns of heavy wire, around which and in inductive relation thereto, is placed a second coil consisting of many turns of finer wire. By this simple arrangement currents of extremely high frequency, and any potential the coils will withstand may be generated.

A simple form of Tesla's arrangement is shown in Fig. 4, P being the primary and S the secondary coil of the high frequency transformer.

A remarkably efficient type of high frequency transformer has lately been constructed for the author, with which we are able to obtain a fairly continuous discharge with an ordinary 16-plate static machine by increasing the capacity of the jars, and making 1 primary answer for 2 secondary windings in an Oudin resonator. This latest type of transformer is a combination of the well-known Oudin form and the Tesla principle.

A sixteen-plate static machine, running at ordinary speed, will so excite this new transformer that an effleuve 12 inches long will discharge from the secondary terminal. In general appearance and construction it is very similar to the familiar upright Oudin resonator mounted on a table with spark gap and condensers underneath. In the Oudin type eight or more turns of heavy copper wire is wound on the

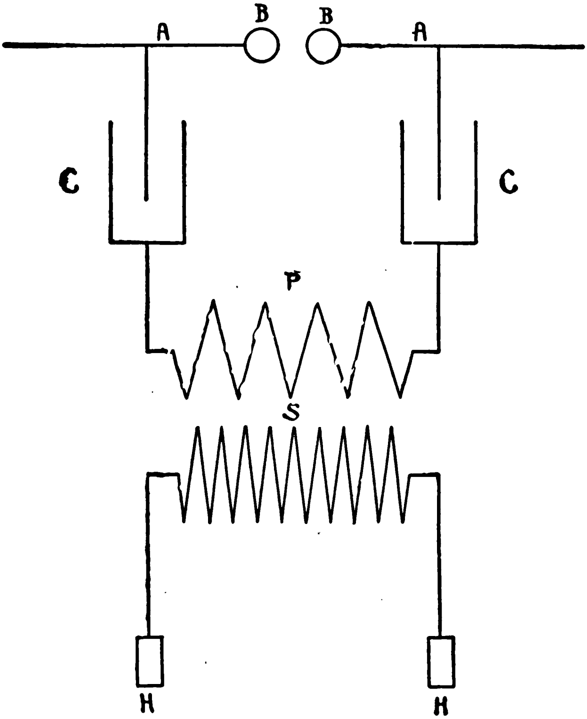


FIG. 4.

lower end of a wood cylinder and is connected directly to 40 or more turns of much finer wire wound in grooves upon the balance of the cylinder. The lower or heavy coil, then, is the primary and the upper fine part the secondary. But small attention is paid to the insulation since the coil consists of but a single layer of wire. This style of resonator is made with two layers of wire and it is of the highest importance that the two layers should be well insulated from each other. This is accomplished by a combination of beeswax and resin. That a comparatively thin layer of this is sufficient is peculiar, since a piece of plate glass ⅜-inch thick fails to stop or diminish the discharge from the top of the resonator. The lower end of the secondary is grounded, which seems to add greatly to the volume discharged. The primary is put in direct connection with the outside coatings of the Leyden jars, of which there should be two on each side connected in parallel. The ordinary pair of Leyden jars supplied with a static machine have not enough condensing capacity; hence, another jar is added, practically doubling the capacity of one jar. When these jars discharge a very heavy spark is the result. The consequent induced discharge generated in the outside coatings of the jars is of equal volume, and in the belief of the writer contains energy of at least one ampere for the brief time it is passing. This discharge must be in harmonious relation to the primary winding on the coil. The condensing surface of each jar consists of about 40 square inches of tinfoil, or about 80 inches connected with the machine. This amount must not vary one way or the other more than five inches without seriously affecting the volume discharged from the top of the coil. For instance, one jar only on each side will give a secondary discharge of but three inches, while two jars on each side, or one jar large enough to contain 80 inches, will give a feathery effleuve 12 inches long at each impulse. To get a fairly rapid or continuous discharge with so much condensing surface a twenty-four-plate static machine should be used and the dischargers separated 1¼ inches. It is also desirable to muffle this spark, as the noise soon becomes a nuisance.

Now that the reader's attention has been called to the three methods by means of which high frequency currents may be generated, let us consider in detail one, and in our opinion, the most important of these methods, i. e., how a sixty-cycle ordinary street lighting current of 100 volts may be transformed into a high frequency current of over a million volts and oscillating over a million of times in a single second. We shall use the Tesla method for this illustration, since it is the one employed in the most modern high frequency apparati of great power. This transformation is not the result of a single process, but consists of three separate and distinct transformations, which will now be considered in detail.

In Fig. 5 is shown the wiring diagram of the Tesla circuit. It will be noticed that the alternating current mains has been marked "low voltage, low frequency." This is the commercial alternating current which usually has a periodicity of 60 cycles, and a potential of approximately 100 volts. If the direct current only is obtainable a rotary convertor is used to convert the direct current into the more desirable form.

What is generally called the "alternating current" has approximately sixty cycles per second, or, as it is sometimes called, 7,200 alternations per minute. This means that in one second the current passes through 60 complete periods or cycles. Let us assume the current starts at zero value (see Fig. 6.) and increases in a positive direction along the curve A B. When the current reaches B it has attained the maximum positive potential. It then decreases along the line B C until it again arrives at zero as shown at C. Continuing along the line C D E the current traces a path below the zero line of the same shape and size as that above, arriving finally at the point E on the zero line ready to commence another cycle. Along the line A B C is one alternation and along the line C D E is another. The complete curve A B C D E is a cycle. Hence there are two alternations, one positive and the other negative, to every

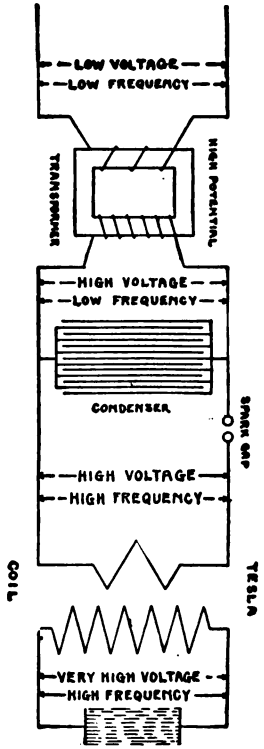


FIG. 5.

cycle. Electricians always speak of so many "cycles per second" or "alternations per minute," and never reverse the terms. This is sometimes confusing to the non-technical mind as the manufacturer uses the more scientific term "cycles per second," while the local electrician usually refers to his current as so many "alternations per minute."

In commercial electric lighting and power work 25 cycles per second is called a low frequency current, while 133 cycles per second is considered a high frequency. To the physicist and manufacturer of therapeutic high frequency apparatus, however, 133 cycles per second is a low frequency. The latter consider it a current of high frequency only when it changes its direction thousands of times per second. These extremely rapid rates of vibration are not obtained by mechanical means, an electrical arrangement being far more satisfactory.

In Tesla high frequency apparatus the alternating current is passed to the primary winding of a high potential transformer which changes the 100 volt current to one having a maximum potential of about 30,000 volts *but does not alter the frequency.* The current is still a 60-cycle current. This is the first step in the transformation of our low potential, low frequency current to one of high potential and high frequency. Notice the first step increases the voltage only, *but leaves the frequency unaltered.*

In the second step of the transformation the periodicity is increased, while the voltage is left unaltered. The high voltage, low frequency alternating current is led from the secondary of the transformer (Fig. 5) to a condenser of suitable capacity. In effect this condenser may be considered a large number of Leyden jars such as are employed with static machines. The purpose of this condenser is to store up electrical energy at a comparatively slow rate and liberate it rapidly, that is, as a disruptive discharge. Referring again to Fig. 6, say the condenser charges at an even rate along the line A B. The potential at the terminals of the condenser, and hence at the two terminals of the spark gap, rises until the insulating layer of air between the spark gap balls breaks down, due to the intense electric stress. A discharge across the gap takes place and the stored up energy of the condenser rushes across the gap.

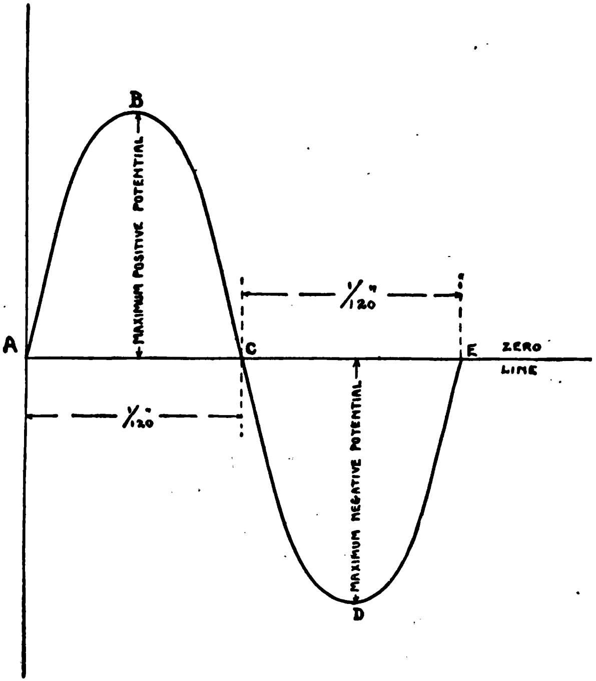


FIG. 6.

The disruptive discharge of the condenser across the spark gap as previously explained, gives to the current its highly oscillatory character. This constitutes the second step of the transformation of our low potential, low frequency current, in which we have changed the frequency *but left the voltage unaltered.* Notice this is the reverse of the first step, where we raised the voltage and left the frequency unchanged.

Now comes the third and last step of our transformation process. It will be noticed by referring to Fig. 5 that the current in passing across the spark gap and the condenser is forced to oscillate through the primary winding of the Tesla coil. Now it is this heavy amperage rapidly vibrating current flowing in the primary, which induces the powerful current of enormous voltage and great frequency in the secondary of the high frequency transformer or Tesla Coil. This completes the transformation.

For the sake of clearness let us recapitulate the facts in the above process. We started with a current of 100 volts and 60 cycles per second. The first step raised this potential to approximately 30,000 volts but left the frequency unaltered. The second increased the frequency to an enormous periodicity but did not change the voltage. The third and last step accomplished a further increase of voltage. The final result of the transformation, or series of transformations, is a current which is extremely different in its properties and behavior from the current as it originally came from the street mains. Currents at such enormous frequencies and potentials seem to set aside some of the fundamental laws of electrical science. Insulators act as if they were conductors, and conductors behave like insulators. Electricity is passed through the body at a pressure which under other circumstances would prove instantly fatal. One surprise follows another until we are prepared for almost anything.

Perhaps the most striking difference in the methods employed by foreign and American manufacturers of high frequency apparatus is in the type of transformer used to charge the condenser which is a part of every high frequency apparatus. Abroad, whether the apparatus employed the principles of d'Arsonval, Tesla, or Oudin, the current used to charge the condenser or Leyden jars was usually either that from a static machine or induction coil. In the most advanced types of American high frequency apparatus a high potential transformer having a closed magnetic circuit is employed to charge the condenser, the primary of the transformer being supplied with an alternating current from the commercial lighting circuit. A rotary being employed if the street circuit happens to be the direct Edison current.

Fig. 7 shows one reason why the transformer having a closed magnetic circuit is more efficient than one having an open magnetic circuit. The diagram on the left illustrates the path of the lines of force in the ordinary induction coil, which is a type of open circuit transformer. Notice that the lines of force are compelled to go through the air in order to complete the circuit from one end of the core to the other. In the diagram on the right is shown the closed magnetic circuit transformer. In this type of transformer the lines of force are practically all within the iron core and have a direct path of low resistance from one end of the coils to the other. When it is considered that the reluctance (magnetic resistance) of air is over 2,000 times that of transformer iron it is evident why the transformer having a completely closed magnetic circuit is so far superior to one having an air gap through which the lines of force must pass.

The first regularly manufactured high frequency apparatus especially designed for therapeutic treatment, which employed a transformer of a closed magnetic type and a rotary converter to render the apparatus applicable to the direct current lighting mains, appeared upon the market something over four years ago and has since been improved very materially. Previous to the appearance of this apparatus various forms of current interrupters or break wheels were employed which required more or less attention and were often a source of trouble and expense Then again, their use was limited to the inefficient open magnetic circuit transformers or choke coils, since the inductance of the transformer having a closed magnetic circuit was so great that a break wheel could not be practically employed. The introduction of the rotary converter as a part of the apparatus, placed the direct current machine on the plane of the apparatus designed for the alternating current only, and gave to the profession the practical high frequency apparatus for use on the direct current circuits.

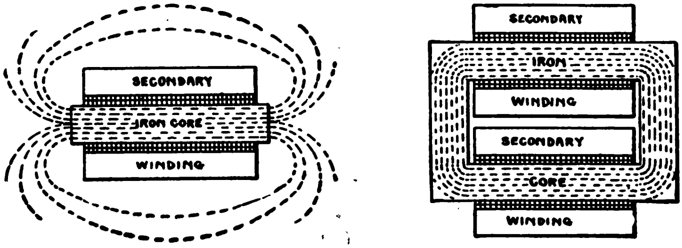


FIG. 7.

The extended description given to the closed magnetic circuit transformer has been largely for the purpose of giving our readers definite ideas of the transformation of electrical currents. Such an apparatus, however, while valuable to the experimenter and specialist in this line, has many disadvantages when employed by the physician who can afford but one machine.

The static machine is somewhat out of its class when used for X-ray work—especially radiography—and cannot in any sense replace the high frequency coil, and it might as truly be said that the coil cannot be made to take the place of the static machine in doing other than *X*-ray or high frequency work.

The need for an improved type of high frequency apparatus has prompted the construction of the model shown in Fig. 43.

This consists of a closed core, oil immersed, step-up high tension transformer which delivers a secondary voltage of about 35,000 volts together with a Condenser, a Tesla Coil, a d'Arsonval Solenoid and an Oudin Resonator, either of which may be employed separately for distinctive effects, the choice being governed by a high tension modality selector switch.

An Improved High Frequency Apparatus Combining Oudin, Tesla and d'Arsonval Currents.

CHAPTER XXXVII.

HIGH FREQUENCY APPARATUS FROM A THERAPEUTIC STANDPOINT.

Having explained the fundamental principles upon which high frequency apparatus is based, let us now consider the effects produced in the character of the oscillatory current, by the variation of the several components of the apparatus, the object being to obtain the different therapeutic effects.

In high frequency apparatus it is desirable to provide means for varying the frequency of the current produced, in order to obtain the various therapeutic effects. Let us see how this variation of the frequency of the current may be best accomplished.

There seems to be a prevailing idea that varying the length of the spark gap materially changes the frequency in the circuit. Let us see what occurs as the length of the air gap is altered.

If the gap is short the condenser is changed to a relatively low potential, but it is charged a large number of times in a given period. If the gap is long it is charged to a higher potential, but is charged less often. This variation of the length of the gap alters the appearance of the discharge, but it does not materially affect the frequency of the oscillatory wave train. The circuit has a definite rate of vibration of its own, dependent upon the values of the inductance, capacity and resistance. This rate of vibration is practically independent of the length of the spark gap, which only controls the rate at which the condenser is charged and discharged. We have stated that the frequency is "practically" independent of the gap length, but the rate of oscillation is theoretically changed an extremely small amount by the variation of the length of the gap. This is due to the change of resistance of the gap as its length is altered. This change is negligible, however, in the type of apparatus we are considering within ordinary ranges of operation as the resistance to oscillatory currents of the hot gases of which the gap is composed, varies only slightly with the length.

Since the variation of the length of the spark gap does not accomplish our purpose, let us consider how the frequency may be changed for therapeutic purposes.

Those of my readers who have investigated high frequency apparatus have no doubt heard much of what is called "resonance," and as some have not a very definite idea of the meaning of this term, we shall endeavor to explain its connection with the class of apparatus under consideration.

In the case of acoustic resonance, in order that one tuning fork may be able to excite vibrations in another, the fork producing the vibrations must be strictly in unison with the fork receiving them. Any variation in the period of the sounding fork, by overloading it for instance, checks the effects of its resonance.

In a similar manner we may consider the electrical phenomenon. In a high frequency circuit resonance exists only when the inductance and capacity bear a certain definite relation to each other. If either be changed ever so little, resonance is destroyed. This relation is determined by a well defined law, based upon a mathematical equation.

This applies equally well to circuits used in wireless telegraphy, as it does to the type of apparatus we are considering. Without resonance Marconi could not have sent his famous message across the Atlantic.

Referring again to the matter of variation of the frequency in high frequency circuits. It is a fact that the frequency may be altered by changing either the capacity or inductance of the circuit. But in apparatus of this character it is highly necessary for efficient and economical operation, that the condition of resonance be preserved. Changing either the capacity or inductance alone alters the frequency to be sure, but it also destroys resonance, that is, throws the apparatus out of tune or balance. We have also seen that varying the length of the spark gap does not to any great extent change the frequency of the oscillatory currents. How, then, are we to change the frequency and still preserve resonance?

This result has lately been accomplished by a device for varying the frequency of the oscillating current produced by changing *simultaneously* the capacity and inductance of the circuits.

As both the capacity and inductance are varied a definite amount in accordance with a well known law, resonance exists at all times and under all conditions. This insures maximum efficiency and economical operation, besides placing no limit to the range of frequencies which may be obtained in one apparatus.

As mentioned in Chapter XXXV., there are three forms, or types, of high frequency apparatus being manufactured at the present time. From a therapeutic standpoint, Dr. d'Arsonval must be given most of the credit for the early research work in this field, as he was the first to discover and announce the therapeutic value of high frequency currents.

Shortly after d'Arsonval's preliminary work was done, Dr. Oudin conceived the idea of tapping a coil of fine wire onto the d'Arsonval shunt coil, and in that way secure a current having almost perfect resonance. His apparatus was called a Resonator, and is excited either from the static machine

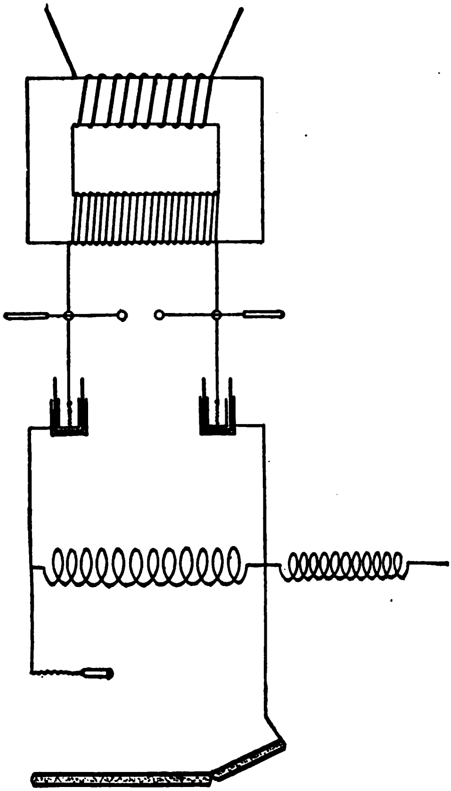


FIG. 1.

or induction coil. As the physics of this apparatus has already been gone into we will briefly consider the Tesla coil—a product of this country.

Nikola Tesla is an electrician who must be given credit for many important developments in the alternating current field; it was his idea to obtain high frequency currents direct from the alternating current mains, by a series of transformations, condenser discharges, and spark gaps. The process was so unique and satisfactory that Dr. d'Arsonval, in a public letter published in the "Archives d'Eléctricité Médicale," dated October 25, 1910, states "that it was not until Tesla, in the year 1891, gave to science a method to produce high frequency currents of great intensity that he (d'Arsonval) was able to introduce this modality successfully into therapeutics. All the former devices were inefficient in their output for auto-condensation or auto-conduction treatments."

In spite of a declaration of this sort from such an authority, some manufacturers are still turning out apparatus of d'Arsonval's early design. The original machine was energized from a primary apparatus such as the static machine or Rumkorf coil, and the manufacturers who later adopted this design, slightly altered the primary winding so that it could be connected to the lighting mains, otherwise no material departure has been made from the original design.

The principal fault with the apparatus just described is that the condensers being of the Leyden jar type are very fragile and of too small a capacity. Instead of using the modern Tesla coils, the old d'Arsonval coils are used. Figure 1, herewith, shows the theoretical diagram of such an outfit. It will be noted that the spark gap is in a shunt circuit, and that the patient's circuit is also shunted for auto-condensation, with the result that the milliampere meter shows an excessive current, ranging from 1000 to 1200.

Such apparatus has too low a potential to be really effective. A very thin di-electric—usually a sheet of fiber about one-fourth of an inch thick—is generally used. The extreme thinness of the di-electric, which is the insulation interposed between the patient and the metal plate of the auto-condensation pad, at once betrays the absence of sufficient potential. This di-electric should not be less than one and one-half inches in thickness, if the machine is properly designed.

The milliampere meter in this instance simply indicates that there is a certain charge in the metal plate of the auto-condensation pad and that part of the patient's body within from one-half to three-fourths of an inch of the pad.

The Tesla apparatus, diagrammatically shown in Figure 2, herewith, is more modern, and consists of a transformer, stepping the voltage up from 110 to approximately 10,000 volts. A metal foil and mica condenser of extremely large capacity is shunted across this secondary circuit, which in turn is passed into the primary winding of a Tesla coil having a series spark gap inserted in the circuit. The current induced in the primary winding of the Tesla coil is allowed to pass into one of several secondary coils, the operator making selection of the proper one to be used by the class of work he wishes to do. For instance, the ideal Tesla High Frequency Apparatus has one coil for auto-condensation, another for the Oudin Current, another for local application of the d'Arsonval, another for auto-conduction, etc., etc.

Such an apparatus, although capable of delivering perhaps several thousand milliamperes in diathermy usually has a maximum milliamperage of not to exceed 600 or 700 milliamperes in auto-condensation.

These Tesla secondary coils all bear such magnetic relation to the primary winding as to insure the highest efficiency in conversion.

It is a fact worthy of mention that the high blood pressure due to peculiar conditions frequently found in young people is, as a rule, lowered by high milliamperage, low potential modalities, while cases of high pressure in patients considerably past middle life, accompanied by hardened arteries and other degenerative changes, the low potential

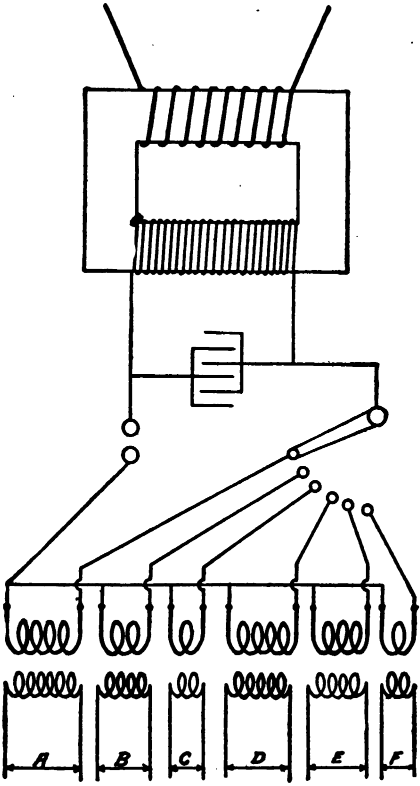


FIG. 2.

—regardless of the amount of milliamperage used—has but little permanent effect, and in many instances no effect whatever is noticeable, while 90 per cent of these cases will respond to the higher potential treatment.

Too little milliamperage, regardless of how high the voltage might be, would be useless, and too low a potential, regardless of the amount of milliamperage available, would cause an equal barrenness of results. The experience of the author, coupled with that of other confrères, has shown that the proper amount of milliamperage ranges from 250 to 500, providing the potential is high enough, so the patient's entire body is thoroughly immersed in a dense field. The milliampere meter, of course, will not indicate the potential, nor will it show how extensive the field is.

The most practical method for ascertaining the density and extent of the field is by making use of an ordinary vacuum electrode for exploring purposes. If the potential is high enough, so that the patient is wholly immersed in a dense field, this vacuum electrode, when held in the hand of the operator, and without his having any connection whatever with the machine or with the patient, should show a faint glow when held a distance of at least eighteen inches from any part of the patient's body.

The author first used the old d'Arsonval coil principally for his high frequency work, but later changed to the Tesla High Frequency Apparatus.

High frequency therapy is not too old as yet to admit of various hypothetical theories. In glancing over various pieces of technical literature, the author noted with interest that some physicists have advanced the theory that high frequency currents do not penetrate through the subcutaneous tissue, and whatever good is secured from the administration of high frequency currents is derived from the effects produced upon the cutaneous and subcutaneous tissues only, and if any systemic effects are produced, it is wholly through increased elimination of CO_2 through the perspiratory glands.

Since the more efficient Tesla coil has been available there has been undoubted effects produced that could by no possibility be due to this cause (skin effect) ; at least this is true of the author's experience and many other confrères with whom he has been in consultation. (See page 317.)

The most plausible theory of the effects produced on the viscera and the blood stream is the direct passing or molecular bombardment of the High Frequency or Hertzian waves, or to the inductive action caused by the rapid change of polarity of the charge.

In either case it is logical that the effects produced must be in direct ratio to the potential of the charge.

We as physicians are constantly on the lookout for improved methods, apparatus, appliances and technique, and if we stop to argue as to the whys and wherefores of the various propounded theories, we are rather skeptical as to how much ground we would gain or how much good we would accomplish. Suffice to say, the high frequency currents have been conclusively proved an indispensable adjunct in medicine, and it does not matter so much with the physician as it does with the physicist as to how these various results are obtained.

The author does not claim to be the court of last resort on this question, but he has the clinical evidence to back him in every assertion he has made.

CHAPTER XXXVIII.

THE ACTION OF HIGH FREQUENCY AUTO-CONDENSATION ON ARTERIAL DISEASES.

Under this heading, we will confine ourselves to Arterio-Sclerosis, Nephritis, and Apoplexy. Nephritis and Apoplexy, according to the popular theory, are caused by Arterio-Sclerosis. One of the most prominent symptoms of Arterio-Sclerosis, in nearly every instance, is high blood pressure.

The reduction of high blood pressure (hypertension), together with proper diet, aids materially in removing one of the pertinent symptoms of the aforementioned diseases.

High blood pressure itself is not necessarily a pathological condition; it is, as a general rule, merely a manifestation or symptom. At the present time, the three principal methods employed in lowering high blood pressure are: Surgery (blood letting), Internal Medicine (the administering of nitrites and nitrates), and electricity. Blood letting gives only temporary relief, and the administering of internal medicine generally employed for this purpose, in nearly every instance, produces heart depression.

The employment of electro-therapy, by means of a high frequency auto-condensation couch, lowers the blood pressure, without producing heart depression, and in practically every case the fall is more permanent.

In order to explain the action of the high frequency currents on arterial diseases, let us trace the etiology of arterio-sclerosis. The origin of this disease is now directly traceable, to a large extent, to a toxemia or poisonous condition arising from some germ process, probably present in the intestinal tract. This toxemia sympathetically affects the entire system and invariably increases the internal body resistance. Thus the heart is called upon to work harder, and in consequence thereof the blood pressure automatically is raised and expands or dilates the arterial walls. The increased body resistance, together with other causes, has a tendency to make the blood stream sluggish, or, in other words, circulate more slowly.

The blood itself is composed partly of solids, which includes lime salt. These solids are held in suspension in the blood stream only when in a constant state of agitation, caused under normal conditions by the alternate dilatation and contraction of the arterial walls. The sluggish circulation of the blood allows the lime salt to gradually precipitate and deposit itself on the inner walls of the arteries while they are in a dilated state.

This calcareous substance being deposited on the arterial walls while they are expanded has robbed them of their normal elasticity. We now have a typical case of arteriosclerosis, the literal definition of which is "hardening of the arterial walls."

Summing up the symptoms present in this disease, we have the following pertinent factors to consider and eliminate:

1. Toxemia.
2. Increased Internal Resistance.
3. High Blood Pressure.
4. Solidified Lime Deposits.
5. Dilatation of the Arteries.
6. Excess of Carbondioxide.
7. Excess of Uric Acid.
8. Excess of Urea.
9. Faulty Metabolism.

The action of the high frequency auto-condensation current on such conditions, considered seriatim, is:

First. It has a more powerful action on all forms of germ life than any other form of electricity.

Second. We have every reason to believe, judging from clinical experience, that by means of a molecular or atomic massage, the increased internal body resistance is lowered materially.

Third. The use of a sphygmomanometer before and after treatment conclusively shows a fall anywhere from five to fifty cubic millimeters. A sphygmomanometer reading twenty-four hours after the treatment will show that there has been only a slight raise in the blood pressure since the last reading was taken. This fall has been secured positively without producing heart depression.

Fourth. Numerous physiological laboratory tests have proved that with the high frequency current we can disintegrate a calcereous substance, and we have every reason to believe that the same action takes place in a case of calcareous deposits on the arterial walls.

Fifth. With the lowering of the blood pressure and the disintegration of the calcareous deposits, it is very natural to infer that the arteries will regain their normal diameter and elasticity.

Sixth. A high frequency current positively stimulates the elimination of carbondioxide.

Seventh. The immense amount of ozone, or pure oxygen, set free along the path of high frequency currents takes care of much of the waste products of the body, by hastening their elimination through proper channels, laboratory tests show this to be the case with uric acid.

Eighth. This also holds true in the elimination of urea.

Ninth. A few moments on the auto-condensation couch will convince the most skeptical practitioner that high frequency therapy corrects faulty metabolism to a degree which will be surprising.

A MODERN HIGH FREQUENCY APPARATUS.

CHAPTER XXXIX.

DIA-THERMY.

We are chiefly indebted to Dr. Franz Nagelschmidt, of Berlin, for most of our information regarding the subject of Dia-thermy, its method of application, the therapeutic indications, and the results acquired. We include this last phrase advisedly, for we believe that Dr. Nagelschmidt is the greatest enthusiast for this method of treatment.

For the successful application of this treatment, we require a high frequency apparatus in which the oscillations of the current are only partially damped. An apparatus built on the Victor-Tesla plan of transformation satisfactorily answers such requirements, as the oscillations in these outfits are only very slightly damped.

The terms "thermo-penetration" and "electro-coagulation" are synonyms of the term "Dia-thermy." Dia-thermy is a term given to a comparatively new high frequency technique. It means the heating of diseased tissue by electrical currents of high frequency. This heating can be easily localized and measured, and this without any of the phenomena which we usually associate with an electric current.

Dia-thermy also gives us a means of attacking diseased bones, or, at all events, the organic substance of them. For medical treatment of internal disease, the intensity of the current and the size of the electrodes are so adjusted that the rise in temperature is but slight, whereas in surgery, we use a far greater degree of heat in order to produce a destructive action.

On superficially heating a bone, we observe a white, chalk-like discoloration at the dia-thermic spot. If we now chisel away this spot, we find that the white discoloration of the bone extends to the full depth of the coagulation zone, but directly one reaches the limits of the coagulation, the tissue reassumes its healthy color, a rosy gray, with punctiform blood spots.

A temperature of 107.6 degrees F., at which separation of globuline takes place, is not sufficient for surgical treatment, where we require at least 158 degrees F., the temperature of actual coagulation. The temperatures which we deal with in dia-thermy are relatively low when compared with those used in the Paquelin and Galvanic cautery.

It is without doubt possible to obtain by dia-thermy still higher temperatures up to carbonization of the tissues with black discolorations. The quantity of the heat evolved may be regulated at will by varying the strength of the current and the size of the active electrode.

With a large active electrode, the temperature of coagulation is reached only after the lapse of considerable time. With a small active electrode, however, which may vary from $\frac{1}{16}$ of an inch to ¾ of an inch in diameter, the coagulation can be rapidly produced, with relatively weak currents.

The following experiment will show how an intense superficial action of small depth may be obtained. Take a thick piece of meat and apply an indifferent electrode to one side and a small active electrode to the other side, and turn on a weak current for a considerable period. We have in this way obtained a deep action as at "A" in Fig. 1.

If now we apply a strong current for a short time, we shall obtain a more superficial action as at "B." In neither case is there any evidence of action at the indifferent electrode. If, on the other hand, we take two small active electrodes and pass a weak current for a long period, we get a cylindrical region of coagulation right through the whole thickness of the flesh from electrode to electrode as at "A." Fig. 2. With a stronger current and a shorter time we get a superficial coagulation in the neighborhood of both electrodes as at "B."

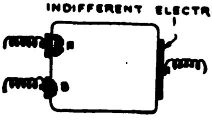


FIG. 1

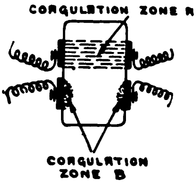


FIG. 2

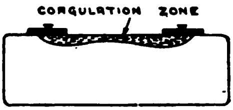


FIG. 3

This experiment throws much light on the correct technique to be used in the surgical application of dia-thermy.

A dia-thermic current is essentially a d'Arsonval current and belongs strictly within the realm of high frequency currents. While the physical aspect has been considered in another part of this work, a few additional points might be given here to strengthen what has already been written, although, in some instances, there may be repetition.

The fundamental thought to bear in mind when first entering the domain of high frequency phenomena is the oscillatory character of the condenser discharge. Instead of a single spark, as appears to the eye in the discharge of the leyden jars of a static machine, there is, in reality, a bound and rebound, or passing to and fro, until the charge is neutralized by diminishing discharges. (See illustration, page 304.)

This sudden, disruptive discharge breaks down the cohesion between the particles, or ions, and they fly off into space, in a diffused oscillating state.

Since the enunciation of the Electron Theory, the electron is regarded by science as the ultimate structural unit of all matter and energy.

Prof. Elihu Thompson says that "in all probability matter itself is an electrical phenomenon."

Prof. LeBon, of Belgium, author of "Evolution of Matter," "Evolution of Force," etc., says, "It is from the intra-atomic energy manifested through the dissociation of matter that most of the forces are derived, notably electricity and solar heat."

The corpuscle electrons repel each other, but form alliances in groups constituting the ultimate structure of all known chemical atoms.

These atoms are a grouping of negative ions, held in harmonious groupings by positive ions.

The attractions and repulsions of the positive and negative signs are the essence of electric phenomena in all the various modalities.

High frequency currents are the latest, most flexible and most useful of the electric currents of this day and among the safest in use, for the reason that they are free from electrolytic action and can be administered with great accuracy of dosage.

Water of a very low pressure, or while trickling along the surface of the ground, will divert its course for any little pebble or obstruction.

A jet of water under pressure exerts a decided impact which increases with pressure and volume. The results of large volume and heavy pressure are familiar in placer mining.

A tiny jet under extreme pressure may have sufficient force to cut or wash the flesh from the bone of the tip of the finger, but let the same jet, under the same pressure, be atomized and it would do no harm but might be made to nourish and refresh the most delicate flower, then evaporate and ultimately become invisible.

Again, let a large mass of stone, brick or any solid, fall from a considerable height upon a workman and it would prove instantly fatal; but let the same mass fall in the form of a fine powder and the workman could move about in it unharmed.

The currents of high voltage, when changed to such a high rate of oscillation that the nerves and muscles do not respond to them in a gross way, are rendered safe and can be passed through the body in large amounts, as harmlessly as sunlight passes through glass.

The sun's rays meet with sufficient resistance to warm the glass and can be so concentrated as to melt it, and just so the high frequency currents can be used to produce warmth and physiological hyperemia with increase of function, or so concentrated as to destroy tissue and become available for surgical aid by heat coagulation, dessication, fulguration, destructive arc, etc.

It is a law of physics, that arrested motion is transformed into heat, which can be easily demonstrated by the high frequency current, and that it is free from electrolytic action is shown by the following experiments.

When these currents are passed through water, only the result of arrested motion is observed. There is no electrolysis, even when changed into steam, and a solution of pot. iodide and starch can be heated in the same way without discoloration.

A sufficient amount of current can be passed through the body to bring the filament of an incandescent lamp to a full glow, without harm or discomfort, though there must be some effect as a result of arrested motion.

The high frequency currents are the only agency by means of which we can heat the tissues through and through without excessive accumulation or action upon the surface.

It is a fact that the highest temperature is developed *between* the electrodes, which, if the electrodes are of equal size, with the current passing through a homogeneous resisting medium, will be about midway between them. For instance, passing a sufficiently heavy current, say, one and a half amperes through a raw potato, the resistance will soon develop sufficient heat to cook and cause chemical and physical changes which, upon cutting along the path of the current, will be found greatest at the center and comparatively slight near the contact.

Another instructive experiment is to insert three clinical thermometers in a piece of raw liver along the path of the current. The same law of physics will be again demonstrated with the same result, viz., arrested motion transformed into heat, and it will be noted that the center thermometer registers highest.

When this current is passed through a raw egg, instead of being cooked hardest at the ends. or outside as in boiling, the result is most apparent in the yolk.

When the current is passed through raw egg albumin in a U tube by means of metal strips in the upper ends, the heat will coagulate the albumen at the bottom while the upper portions remain cool.

This will perhaps be sufficient study of the physical, and we will next consider the physiological effects upon living tissue with active circulation and organic function.

Dr. A. C. Geyser reports an experiment that largely clears this matter, which is as follows:

"The temperature per rectum of a guinea pig, when disturbed, will register about 100° F. Two metallic, or sponge-covered, electrodes are placed upon either flank of the animal, and the current turned on. As there is no sensation, beyond a slight feeling of warmth, we need take no special precaution with either current or the animal. In the short space of three minutes the rectal thermometer will show a reading of 105°. This increased temperature may remain from one to three hours without any apparent ill effects upon the animal."

Here, then, we have the circulating blood in no way interfering with the heating effect; on the contrary, we produce all of the essentials of a natural reparative process, heat, relaxation of elastic structures, dilatation of arterioles, increased blood supply, increased oxidation and increased function of the sympathetic nerve and cellular tissues, so that the innate wisdom of the tissues restores a physiologic balance, and the results continue for a varying length of time, depending upon the adequacy of the reaction.

The dose is not so many milliamperes for a certain number of minutes, but an effective amount which must vary with each individual case.

In order that this may be accomplished with certainty and precision the operator must be well grounded in the principles governing the administration, such as time, amperage, concentration, etc., which are determined by well defined laws.

In this connection it may be well to note that the medium voltage and frequencies are of most practical value to the physician, as the apparent medical results diminish with the extremes.

Most of the work is done with voltages ranging from 5,000 to 5,000,000, and frequencies of 200,000 to 2,000,000.

A frequency of 10,000 per second has been arbitrarily fixed as the lowest limit of oscillation, termed high frequency, as muscular tetanization disappears when this rate has been attained.

A voltage of about 10,000 and a frequency of 200,000 gives a pleasant, deep, powerful contractive influence, which, on account of the sense of heat in the tissues is termed Thermo-faradic and is about the lowest commonly employed.

For Diathermy, the higher voltages and frequencies are more satisfactory. The fundamental laws, or rules above referred to, are as follows:

The effects of a current are in direct relation to the time of application for effective dosage.

The effects also vary as to the resistance. The more dense the tissue the greater the resistance, and so the greater the number of heat units in that particular tissue, giving it a selective action.

The effects vary as to the *square* of the amperage. This is a vital point or rule, for if the meter changes from 250 ma. to 500 ma., the tissues or organs between the electrodes are not receiving double, but four times the amount of current, and the heat generated is four times as great. If the meter reading is increased from 250 ma. to 2,000, the meter reading is increased eight times, but the heat units are increased sixty-four times. The concentration of current is in proportion to the area of the electrodes, but if the size is reduced one-half, the concentration of the current is increased four times and the tissues are developing four times the amount of heat, $8 \times 8 = 64$, $4 \times 4 = 16$, etc.

The organs of the body all functionate normally, only within very narrow ranges of temperature, hence it is not wise to pass more than 200 ma. through an electrode of two inches square, or 1,000 ma., through an electrode four inches square.

With large amperage use large electrodes. A heavy clinical thermometer placed between the electrode and body is a material aid in determining the dosage desired in varying conditions.

If one electrode be so large as to be practically a diffusing electrode and the active electrode of a size suited to the case, the current passing between them is pyramid or cone-shaped, according to the form of the electrodes. As we have seen, if one electrode is eight inches square and the other four inches square, the amount of heat in the tissues near the small electrode is four times as great as that near the large one.

No organ or part of the body is so remote that it can not be reached by this mode of treatment, and the depth of concentration can be determined with almost mathematical accuracy.

The natural tendency of all disease is toward recovery, and nature's process is by inflammation, which is a reaction of living tissue to an irritant of some kind.

When the reaction is adequate the recovery is ideal, and no ingenuity of the human mind can improve upon it, but the reaction may be adequate, inadequate or excessive.

Excessive reaction occurs less frequently than the other two and then is confined to only one or two of the factors. It may lead to stasis, necrosis, fibrinous deposits or excessive granulation, etc.

Inadequate reaction, present in most chronic and many acute diseases—even when the process is extending—is an evidence that the irritation is in excess of the ability of the tissues to control it, is a call for assistance, which is most successfully rendered by this modality.

Naturally, the more virulent the infection the less the ability of the leucocytes and cells to take care of it.

In acute gonorrhoea, the leucocytes become overwhelmed with the active germs until they are devitalized and discharged. The active hyperemia ultimately modifies the virulence of the infection, but even when treated under prevailing plans the result is often a chronic infection that lasts for years.

If a large block tin electrode is placed on the abdomen and a suitable, ordinary steel sound is inserted in the urethra and connected to the other pole and a current gradually turned on, sufficient to produce a sensation of comfortable heat in the organ, and maintained for a half hour every day for a week, then every alternate day for two weeks more the result will almost invariably be an adequate reaction, with complete eradication of the disease. Tuberculosis is a type of chronic disease in which the inflammation is inadequate, and not infrequently the bacilli proliferate in the cells. The action and reaction are so nearly balanced that the process goes on indefinitely unless active assistance is rendered. In diathermic treatment, instead of limiting the current to a focus of infection, results are better if large block tin electrodes are applied back and front over the chest and retained in close contact by any convenient means, as lying on one and weighting or strapping the other. In a case with history of or tendency to hemorrhage, the treatment should be commenced with great care, not exceeding three to five hundred ma. for fifteen or twenty minutes. The small amount of tissue of low vitality over the ribs also is a warning to be careful. Gradually the current, especially in incipient cases, can be increased in time to yield comfortable and grateful results. With the large electrodes the amperage can be increased to a thousand or fifteen hundred, even seventeen hundred milliamperes in some cases, with a rise in temperature of one or two degrees by mouth, a flushed face and perspiration on the forehead as well as under the plates, but most patients react more successfully to milder dosage. If a vaccine is used, this procedure will increase the focal reaction and efficiency. If the head of the table is lowered while administering the current, gravity helps increase the hyperemia.

The employment of this modality aids rather than interdicts the use of hygienic, dietetic, medicinal and other measures.

The results of Diathermic treatment of tuberculosis of joints is such that resection is rarely necessary. Apply a tinfoil electrode to either side of the joint and pass current to a point of comfortable heat and maintain for an hour or more a day, being governed by the response of the case. Pain will be relieved very promptly and early cases will clear up. In more advanced cases with discharge, a mild inflammatory action is set up with profuse discharge and clearing of necrotic tissue, followed by healing with very slight deformity.

The underlying principle of securing an adequate reaction must be the guide as to dosage in each and every case. In some cases the indication is to relax and sedate by means of light currents; for instance, to favor the passing of calculi, relieving spasm, etc.; in others, a heavy, concentrated current is required for profound local results, as in the case of tumor or malignant growths.

Electricity has been used almost entirely, whenever employed in cancer, for the destruction of tissue by destructive ionization, galvano-cautery, electric coagulation, or fulguration.

As before noted, all of the bodily and tissue functions are performed normally within very narrow temperature ranges. Normal, healthy, vigorous cells will resist chemical or physical irritants that would destroy those that are immature or unhealthy. All cancer cells are less resistant than surrounding healthy tissue and so their vitality can be destroyed by agents which would stimulate and perhaps strengthen normal structures, and diathermy is an agent which is quite ideal. A malignant growth is more dense and resisting than surrounding structures with low vitality and a less direct, active circulation, and so is peculiarly calculated to accumulate and store heat.

The New York State Cancer Laboratory states that all cancer cells die when heated to 116.6° F. for thirty minutes. Erlich determined by heat tests that cancer tissue maintained at a temperature of 111.2° F. for thirty minutes was no longer viable when transplanted.

Dr. Geyser says that from "practical experience it has been shown that when the entire malignant growth is subjected to an increase of three degrees of temperature for sixty minutes daily the physiology is markedly interfered with. Cachexia is prevented or removed; the tumor mass undergoes a retrograde metamorphosis, individual nodules soften, become smaller, and finally disappear; pain ceases entirely; discharges lessen and lose their offensive odor." In this case the large electrode is located diametrically opposite the lesion and a small one of suitable size over the growth with a clinical thermometer placed under as a guide to determining the heat developed. Turn on current to give a reading of 106° F. and maintain one-half to one hour. Watch elimination to keep down toxemia, but should toxic symptoms develop, lengthen the intervals, but keep using to develop the same heat effects.

The physiological treatment of cancer is still in an experimental stage, but it is an inviting field that is promising, and does not jeopardize the patient's safety or preclude the use of other measures.

The sedative results are well emphasized by the case of a young man of 21 with a violent hysterical mania apparently of abdominal origin, though radiographs of the abdomen as well as of the teeth, head sinuses and chest were negative, urine normal. As hypodermics failed to control him, the attendants had been administering chloroform from two to five times a day for several days. The origin of the symptoms was evidently abdominal. A high frequency apparatus was installed in the corner of his room at the hospital with reophores about 14 feet long, as the patient was inclined to get out of bed and give the attendants a lively fight the moment they were off their guard. Briefly, the first treatment was given by means of a large block tin plate under the patient and another on the abdomen, the patient and electrode being held by three men, and a current of 1,600 ma. passed for twenty-five minutes. In less than an hour a fecal lith about 5/8x7/8 inches was passed into the bed pan; restless night, and violent from 12 to 9:30 next a. m. A second treatment was given of same dosage, and during the next twelve hours 15 calculi were passed, one of which was reported quite large. After this the patient slept eight hours and was quiet until noon of the third day, when he became very violent again and would fight, kick, bite, spit, curse and swear. A treatment of 1750 ma. for thirty minutes quieted him, and after a good night's sleep, took a 40-mile auto ride, and after this he had a ride every day with his attendants for a week, at which time he was taken home.

Usually the electrodes are placed on either side of the body or part to be treated, but this is not assential and often not applicable. A case of Raynaud's disease was treated at a large clinic by massage, external heat, etc., without apparent benefit. The disease was confined to the left hand, the pulse disappeared, tips of the fingers turned black and dried up, and the pain, loss of sleep, etc., were so wearing that amputation was suggested but declined in favor of diathermic treatment. Patient was placed in an auto-condensation chair and 1,200 milliamperes passed for thirty minutes on alternate days with the result that after the eighth treatment pain was relieved and sleep restored, and within two months fingers were normal, nails regrown and recovery was complete.

In spinal lesions, small metallic discs or moist electrodes are placed each side of the vertebra and about two to four hundred milliamperes passed for a sufficient time to insure an active hyperemia of the deep structures which dissolves exudates, relieves pain and restores normal conditions and function even in apparently desperate conditions.

For spinal tenderness and irritation, place the patient comfortably on the table with a moist block tin electrode under the solar plexus and connect with a "ground."

Select a body glass electrode of medium vacuum and increase the current to a sensation of agreeable warmth, which is the proper intensity for sedative results, and take time to remove each sensitive spot.

With the grounded plate to the back of the neck or shoulders, the vacuum electrode gives excellent results in the treatment of chronic sinus disease and suitable vacuum electrodes are practically a necessity for the proper treatment of the eyes, nose, ears, teeth, etc.

The best vacuum electrodes for high frequency application are those which have a "leading in" wire, commonly called "insulated" electrodes. These, as well as the ordinary vacuum electrodes, are of all degrees of exhaustion, and the simplest method of showing whether they are low, medium or high is to hold them over the body of a patient receiving auto-condensation. A low vacuum electrode will light up at a considerable distance above the patient, while a medium one will have to be held closer, and a "hard" one may have to actually touch the patient before it lights up.

Herewith are cited several affections suitable for diathermic treatment: In all forms of tuberculosis of the skin and mucous membrane; in affections of the nose and throat, local anæsthesia by cocaine is sufficient. The pain of the dia-thermic application is so slight that single lupoid nodules may be treated even in children without any anæsthesia. Good results have been reported in treating diseases of the larynx with dia-thermy, against which medicine so far has been quite helpless. Where dia-thermy was used, contrary to expectations, there was no œdema either of the larynx or glottis. Where affections of the larynx are treated by dia-thermy, trachœtomy is seldom necessary.

Tubercular ulcerations of the nose, the ear passages, the vulva and vagina are also amenable to dia-thermic treatment. In varicose ulcer, with scabbing of the flabby granulations and edges a superficial dia-thermy is often of the greatest benefit.

Dia-thermy is a notable step in advance in another class of cases coming under the head of "alterations of the blood vessels." The blood is coagulated by dia-thermic application in the same way as the other tissues, consequently dia-thermy is indicated in nævus vasculosa, hemorrhoids, polypus, and other vascular hypertrophies of the mucous membrane. It is also indicated in angioma cavernosa of the throat and head in young children.

The treatment of hemorrhoids is greatly simplified by this method, since the operation can be carried out under local anæsthesia without hemorrhage.

Dia-thermy is also indicated in benign tumors of the skin, atheromata, cysts, fibromata, myomata, and nævi. Excellent results have been reported in the treatment of furunculosis.

In the dia-thermic treatment of fistula we meet with the same difficulties as with electrolysis. Large external tumors have been successfully attacked by dia-thermy. One case is cited of a tumor measuring approximately seven inches in diameter, which was thoroughly coagulated through and through in ten minutes. Not a drop of blood was lost during the coagulation or the removal of the tumor, although a subsequent examination showed the presence of blood vessels of 5-32nd of an inch in diameter.

If the tumor is subcutaneous or in the interior of the body, dia-thermy can only be used after the tumor has been laid bare by a surgical operation. Then the treatment is exactly the same as though it were superficial.

The absolute asepsis of the dia-thermic operation is one of its strongest points. Consider, for instance, an operation for a sloughing carcinoma of the neck of the uterus. In an ordinary surgical hysterectomy disinfection of the vaginal portion of the uterus is quite impossible, and it is fortunate if the peritoneum is not infected during the operation. It is quite otherwise when the case is operated on by a combination of hysterectomy and dia-thermy. With the aid of a speculum, it is quite easy to attack the vaginal part of the uterus to coagulate it and to sterilize it, with all its bacterial flora, without any fear of hemorrhage.

Dia-thermy enables us to obtain very accurate and fine localization in operations in the neighborhood of important organs, vessels and nerves, the peritoneum, the eye, or the cerebral sinuses.

In addition to the treatment of tumors, a combination of dia-thermy and surgery is indicated in a number of other affections, such as echinococci cysts, suppurating tuberculous glands, diseases of the bladder, including bleeding papiloma, etc.

In conclusion, we may say that the destructive action of heat produced by high frequency currents is indicated in a great number of superficial lesions, and in combination with surgery, it is indicated in a large number of cases of deeper origin. One of its great advantages is the entire absence of hemorrhage. A still further advantage is the possibility of sterilizing deeply seated tissues during an operation and thus obviating the danger of infection of the various body cavities. The principal advantage, however, lies in the fact that during the dia-thermic coagulation neither the blood vessels nor the lymph channels are open, hence there can be no possibility of the dissemination of germs of cancer or sarcoma during the operation.

A CONVENIENT AND PRACTICAL PORTABLE HIGH FREQUENCY EQUIPMENT.

CHAPTER XL.

INDUCTION CURRENTS FROM A THERAPEUTIC STANDPOINT.

A Comparative Study.

An induction current is one generated in a conductor by the influx and egress of magnetic lines of force. Of necessity, they are alternating in character—at one instant being in one direction, the next instant in the opposite direction; but by commutation they can be changed to flow in one direction.

Four different kinds of induction currents are in use for therapeutic purposes; namely, the faradic, the alternating commercial, the static induced, and the sinusoidal, and the chief function of these is largely mechanical, the object being to produce muscular contractions and thereby stimulate cell growth.

Ever since Faraday constructed his first induction-coil, that current has been used almost exclusively for muscular work—and, I regret to say, for nearly every other kind of therapeutic work imaginable, even for the treatment of cancer. Almost every family owns a small faradic machine, and the armamentarium of the physician has been considered incomplete without one; the mechanism being either mounted upon a wall-plate or incased in a highly polished receptacle.

The faradic current produces profound sensory effects, due to its uneven character at "make" and "break"; the "break" being about twelve times stronger than the "make." It is represented above the neutral line in Fig. 1.

The faradic current, therefore, produces a contraction of the muscles, accompanied by a maximum of pain.

Every *turn* of wire in a faradic coil increases the pressure, or *voltage,* of the output; but each added turn of wire also increases the resistance in the circuit.

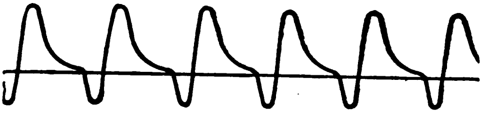


FIG. 1.

Resistance decreases the amperage, i. e., rate of flow, without correspondingly affecting the voltage, i. e., pressure. In an ordinary faradic coil, therefore, the amperage has been so decreased by the number of turns of wire as to be almost inappreciable.

Some writers claim polar effects for a secondary faradic current. This could be so because of the strength of the current at "break," which is uni-directional, only, unfortunately, it does not carry sufficient current to produce polar effects.

The alternating commercial lighting current, and the current from ordinary small generators as well, may be diagrammatically represented as in Fig. 2, which shows a 60-cycle current.

Starting at zero, the voltage (pressure) runs up rapidly, returning to zero again as suddenly, and describing the same angle at opposite polarity below the zero line.

Such a current, while producing muscular contractions and less pain than the faradic, besides having some influence on trophic centers, does not properly fill the office of induced currents as used for therapeutic purposes. The rapid rise and fall of the voltage produces such sensory effects as to preclude the possibility of obtaining sufficient current flow—that is, within the limit of tolerance of the patient—to do the work required.

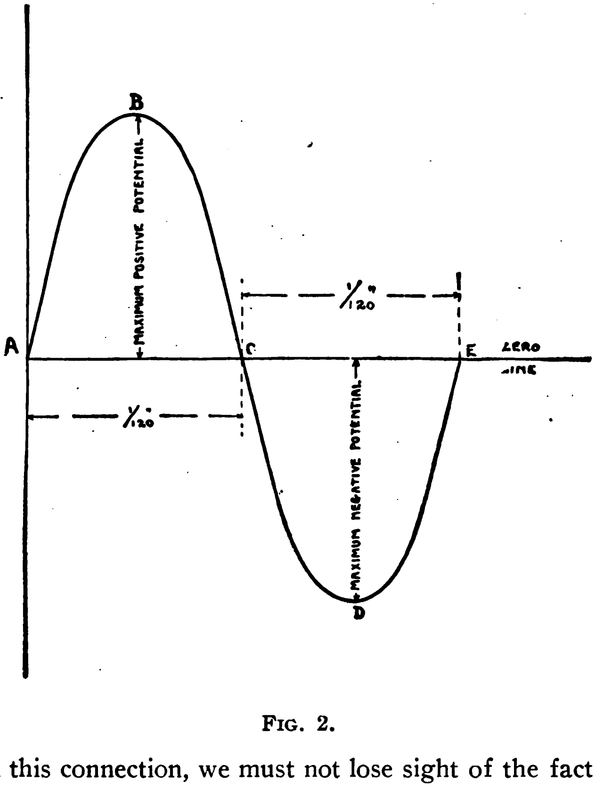


FIG. 2.

In this connection, we must not lose sight of the fact that the current flow, or amperage, has as much to do with the therapeutic qualities of an alternating current as it has with direct currents; the only difference being that the amperage of direct currents gives our polar effects *at the pole,* while the rate of flow of induced currents produces important metabolic and trophic changes in the *interpolar* space.

The efficacy of induced currents, from a therapeutic standpoint, lies, not so much in their power to produce muscular contractions (all induced currents will contract muscles) but more in the *character* of the contractions produced and the accompanying effects upon the tissues traversed.

The static induced current is produced by the disruptive discharge from a condenser and properly belongs to "high-frequency high-potential currents." It may be represented by the following diagram:

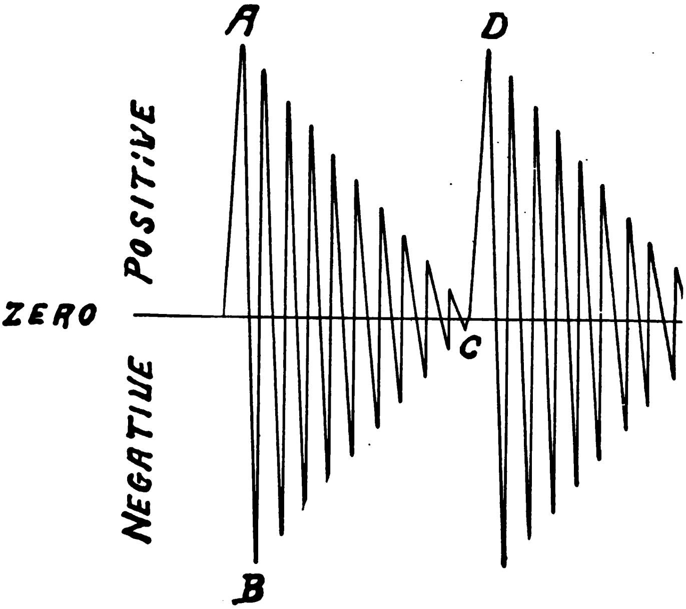


FIG. 3.

Starting at the zero line, the voltage rises rapidly to "A," where the resistance of the air gap between the prime conductors is overcome and a disruptive discharge takes place, sending the voltage suddenly to zero; whereupon it rises on the negative side of "B," alternating back and forth and gradually decreasing until its equilibrium is restored at "C." The voltage then rises again at "D," where another disruptive discharge takes place.

Between the two discharges "A" and "D" there may be millions of alternations and the voltage may be high or comparatively low, according to the length of the spark-gap.

While this current produces muscular contraction, accompanied by less pain than the faradic or alternating commercial current, there are several serious objections to its use. Thus, it is almost impossible to regulate the speed of the machine so as to give the required number of alternations, while it is equally difficult to control the strength of the current—each one-fourth inch separation of the prime conductors making an increase of about 10,000 volts.

The sinusoidal current (so named because its tracing above and below a neutral line resembles the sine of a circle) is produced by a generator much the same as are our commercial lighting currents, except that the field-magnets of the generator are so arranged that the output is materially different.

Many physicians believe that when they have access to the ordinary alternating lighting circuit or install a small alternating generator of any kind, they have a true sinusoidal current or one that will equal it for therapeutic uses. Such, however, is not the fact. The instrument for producing a real sinusoidal current must be built for that purpose. A true sine current is represented in Fig. 4.

Starting at zero-potential, the voltage *gradually* rises along the line "AB" until it reaches its maximum at "B," descending *gradually* along the line "BC" until it reaches zero-potential at "C"; without pause the voltage again rises along the line "CD"—except that now it is of opposite, i. e., negative, polarity—until it reaches its maximum negative potential at "D," from which point it gradually descends again to zero, thus completing one cycle.

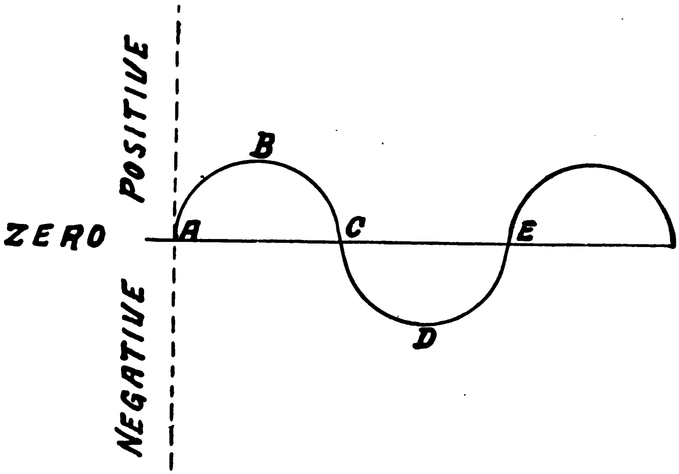
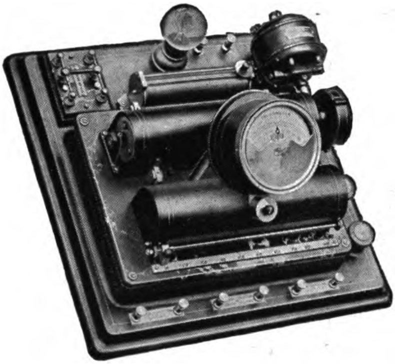


FIG. 4.

It becomes evident that a single modality of this current, be it ever so perfect in character, will not answer all purposes.

True massage consists in causing the muscle to contract and allowing it to come back to normal before it receives the next impulse to contract. If the alternations are too rapid, the muscle remains in a state of tetanic spasm, which simply tires it out. Some muscles respond to a rapid rate, as, for instance, the ocular; some of the long muscles require a much slower rate; while still others require a very slow worm-like contraction, similar to the peristaltic movement of the intestines.

In a sinusoidal apparatus, to meet all these conditions, there should be some means of controlling the length of the sine and allowing any variation of voltage without affecting the integrity of the current. These points should be especially kept in mind when purchasing a sinusoidal outfit.



Multiplex Sinusoidal Apparatus.

A true sinusoidal current yields the ideal massage, because it causes muscular contraction without pain. With it, we can produce contractions strong enough to simulate the worst case of paralysis agitans without causing any inconvenience whatever to the patient.

Favorable reports have appeared in recent literature on the use of the sinusoidal current in relieving deafness, caused by anchylosis of the ossicles. The principal difficulty, however, is that while the sinusoidal current furnishes excellent massage and promotes the absorption of the inflammatory exudate it cannot restore a normal tone to the auditory nerve and its branches, for the reason that it does not furnish a rate of vibration to which the nerve can respond. A rate of vibration of from 6,000 to 10,000, which is the most rapid that can be gotten from any sinusoidal machine, pales into insignificance when we compare it with the "Morton Wave" current, which furnishes from a few up to many millions per second between each impulse, and, at the same time, is the most perfect and painless massage. (See Chapter on "Deafness.")

No means of treating habitual constipation is so universally successful as the sinusoidal current. For this purpose our apparatus must be arranged to give a rate of contraction similar to the peristaltic movement of the intestines.

Proper elimination is the chief factor in maintaining good health, and the principal eliminating organs are the intestines, kidneys and skin, named in order of their importance. The entire digestive tract, some twenty-five feet in length, suffers if there is insufficient excretion from the intestines, the degree of suffering depending upon the cause of the trouble. But the failure to eliminate reacts upon the entire system.

Nature seeks to establish an equilibrium. The result is that the kidneys and skin are overtaxed. The former, attempting to do the work they were never intended to perform, are irritated in consequence, and inflammation results. Not uncommonly is this the indirect cause of Bright's disease.

The skin, not unwilling to share its part of the burden, attempts to eliminate toxic substances intended for other channels which are frequently the cause of acne, urticaria and like lesions, and so it becomes apparent that, in spite of all efforts of kidneys and skin, the great mass of toxic substances generated in the alimentary canal are absorbed by the general system.

The nervous system also suffers from the poison, and headaches and neurasthenia result.

The circulatory system is impaired and the blood, loaded with toxic material deteriorates, evidenced by a decrease in the number of red blood corpuscles.

As direct results of improper evacuation of the intestines, a catarrh of the mucous lining of both stomach and bowels is induced, the tongue is coated, the appetite lost, and either, through the taking of an insufficient quantity of food, or failure of assimilation, nutrition is impaired.

Mechanical obstructions, ulceration and hemorrhoids are also of frequent occurrence. In fact, we might go on indefinitely enumerating the evil consequences of constipation.

To cure a case of constipation is to restore to good health in a large percentage of cases. It is as important to the patient and should be as great a credit to the physician as is a successful operation for appendicitis to the surgeon.

To prescribe laxatives for habitual use is to temporarily relieve only, and to permanently increase the difficulty; but in electricity we have a therapeutic agent for the permanent relief of this ailment that cannot be overestimated.

A constant factor in the cause of constipation is relaxation of the abdominal muscles, the production of which is due to neglect, sedentary habits and corsets. All that is necessary to relieve this condition is to impart a better tone to these muscles by the use of a properly selected sinusoidal current.

Many operators will place one electrode upon the abdomen and the other on the lower dorsal spine, and that is right provided we would only influence the abdominal muscles; but the writer finds it much better to use one electrode—a pad—on the abdomen, and a rectal electrode, such as is shown in Fig. 26, inserted in the rectum. In this way the entire intestinal tract is profoundly influenced, as well as the abdominal muscles. The alternations of the current should be about 15 to 20 per minute, and the seance continued for 5 minutes. In some cases evacuation occurs immediately after the treatment, in some the following day, in others two, three or more treatments are necessary before obtaining a result.

Permanent cures are obtained in from one to six weeks' treatment.

After a cure is effected an occasional treatment is sometimes necessary, possibly once in a month or two, especially if the patient gets careless about his diet, habits, etc.

A loss of sensibility of the nerves of the rectum is another cause of constipation. This is generally due to neglect. The mucous membrane becomes tolerant, and the feces are retained. We have, in fact, a partial paralysis of the bowel, or a loss of vibratory tone, without which no nerve can functionate.

Here we have the strongest indication for the electrostatic wave, which, besides giving massage to the muscular walls, restores a normal vibratory tone to the nerves, not only in the intestinal tract, but in the entire body.

The electro-static wave, or so-called "Morton Wave Current," is a unipolar current, and the arrangement of machine and patient for giving it can be found on page 65.

It is a well-known fact that, with few exceptions, any application of negative galvanism should be followed by massage, in order to stimulate the absorbents to take charge of the products of decomposition set free by electrical action at the negative pole.

Here we are able to save the time of two applications by using another very valuable modality of the sinusoidal current, which I shall term the "sinusoidal galvanic," but which has been heretofore called the "surging galvanic."

Being in one direction, it has the polar effects of a constant current, besides the power to contract muscles as with alternating currents. (See Fig. 5.)

By utilizing the *polar* effects of negative galvanism and the most perfect massage at the same time, we are enabled to treat successfully such cases as optic atrophy, pelvic adhesions, and that greatest cause of dysmenorrhea and sterility, the infantile uterus. With this current I have developed a number of uteri from about one inch up to 2½ inches in from twenty to thirty sittings. This also is the current *par excellence* in anterior poliomyelitis after the muscles have partly or wholly lost their irritability to induction currents. My last case of infantile paralysis, a girl of twenty, who could not walk or even stand without support and whose muscles gave *no response to induced currents*, recovered perfectly in three months under "sinusoidal galvanism" and has since married.

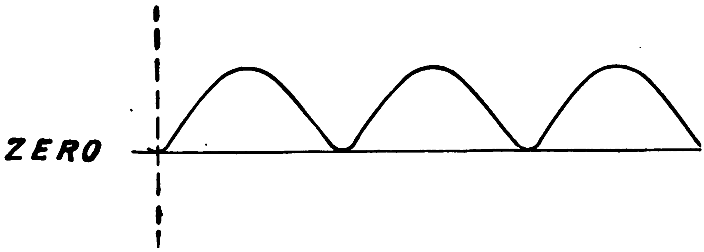
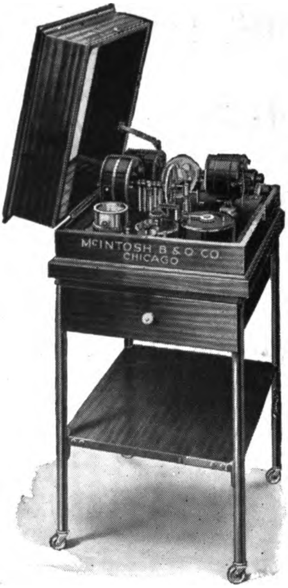


Fig. 5.

There are just as many therapeutic indications for the use of induced currents as for any other kind, and, I regret to state, there are just as many misapplications of it.

One of the principal errors in applying induced currents is in using too rapid an interruption, and for too long at a sitting. If your faradic coil has only the ordinary hammer-interrupter, it will be necessary to cut the current up into periods. This can be done with an automatic interrupter, or by "making" and "breaking" the contact at one of the electrodes.

It is well to remember, also, when using induced currents, that the impulse for the contraction of the muscle is *not sent out from the brain,* but from the battery, consequently the brain is never cognizant of the work being done. It is an easy matter, therefore, to *fatigue* the muscle, and thereby fail to accomplish the prime object of the application. Let your seances be short at first, and you may gradually increase the time as the parts become accustomed to the work.

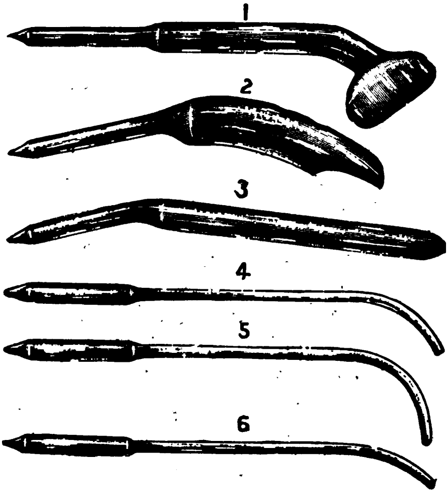


Polysine Generator Affording Galvanic and Sinusoidal Currents.

CHAPTER XLI.

VARIOUS PHENOMENA OF HIGH FREQUENCY DISCHARGES.

The character of the high frequency discharge is greatly altered as the various components of the circuit are changed.



GLASS VACUUM ELECTRODES FOR HIGH FREQUENCY CURRENTS.

No. 1.	Body.	No. 4.	Urethral.
No. 2.	Vaginal.	No. 5.	“
No. 3.	Rectal.	No. 6.	Intrauterine.

For instance, when the spark gap is short and the frequency is high the discharge has somewhat the appearance of a gas flame and possesses many of the properties of a flame produced by combustion. It is hot, as is shown by the fact that it instantly sets a piece of wood afire when it is put between the terminals. The heat may also be felt by placing the hand over the discharge. This flamelike appearance is due to the fact that the main discharge is composed of many smaller discharges, each of these smaller discharges being in turn composed of a large number of oscillations. This is prettily shown by blowing upon the discharge. The blast of air breaks the main discharge up into many smaller ones, but this crude method does not show the individual oscillations of which the secondary discharges are composed. With more refined methods these oscillations have not only been observed, but have been photographed and their wave form analyzed.

In the early days of electricity electricians classed various substances as either conductors or insulators. The former allowed the current to flow through them, but it was supposed that the latter entirely checked the current flow.

The theories of early electricians were not acceptable to one man, however, and that man was Clerk Maxwell. This great mathematical genius investigated the fundamental laws of electricity and incorporated his ideas in the work which only the most highly trained electrical engineers can read intelligently. Maxwell declared all circuits were closed.

Assume for instance that a condenser, such as Leyden jar, is connected to a source of electrical energy. Early electricians said the current flowed to the condenser coatings and there accumulated, no current passing through the glass separating the plates. They said the circuit was "open," the glass preventing the opposite electricities from uniting. Maxwell claimed the current did flow through the glass and that the circuit was a closed circuit.

Maxwell did not admit such a thing as an open circuit. To him all circuits were closed. He called the current which flowed through the glass a "displacement current."

A simple analogy to explain the transmission of electrical energy through an insulator, is the case of a tube filled with water, the ends of the tube being closed by rubber diaphragms. If a vibratory motion be applied to one end of the tube, by moving to and fro the rubber diaphragm, a similar motion will be perceived by touching the other diaphragm at the farther end of the tube. The vibrating motion is in this instance transmitted from one diaphragm to the other by means of a stress in the practically incompressible *water*. In the electrical case the energy is transmitted from one plate of a condenser to the other as a stress in the incompressible *ether*. In both cases the same result is obtained as if the energy had been directly transmitted and had not changed its form during the transmission.

If the frequency be lowered and the spark gap made longer the discharge from a high frequency apparatus assumes the appearance of a violet band of light. At this stage the discharge is more in the nature of an arc than a spark. The heated air caused by the passage of the discharge causes it to assume a curved form, the concave side being down.

If the rapidity of vibration be still further reduced and the spark gap be opened the maximum amount, the discharge has the appearance of that produced from a static machine or induction coil. The periodicity is so low and the resistance in the oscillatory circuit so high on account of the long spark gap, that the discharge does not oscillate persistently as it does when a higher frequency and short gap is used. In this condition the current passes from one terminal to the other as white sparks accompanied by the snappy sound inseparable from the discharge of a static machine or induction coil. In fact the discharge of a high frequency apparatus under proper conditions may be such that difficulty would be experienced in telling from what source the current came, provided only the terminals were visible.

When the voltage and frequency are both high, as they are in the case of oscillatory currents, it is not necessary to make a closed circuit with a source of high frequency currents in order to have a current flowing. If we grasp one terminal of the apparatus, we are as truly connected as if we grasp both. This peculiar property of electricity at high voltage and rapid rates of vibration may be illustrated by experiments.

If we grasp an ordinary incandescent lamp by the outer shell of the socket and at the same time touch the inner contact to one terminal of a machine in action, the lamp lights up. It is well known that to accomplish this result with ordinary currents a wire would have to be attached to each contact of the lamp, i. e., a complete metallic circuit formed. In the case of high frequency currents the current passes from one terminal of the machine through the lamp, through the body as a conduction current, and from the body to the other terminal as a displacement current through the ether. The circuit is closed as in the case of ordinary currents, the difference being that on account of the high voltage and great periodicity of oscillatory currents a metallic or other ordinary conducting circuit is not required.

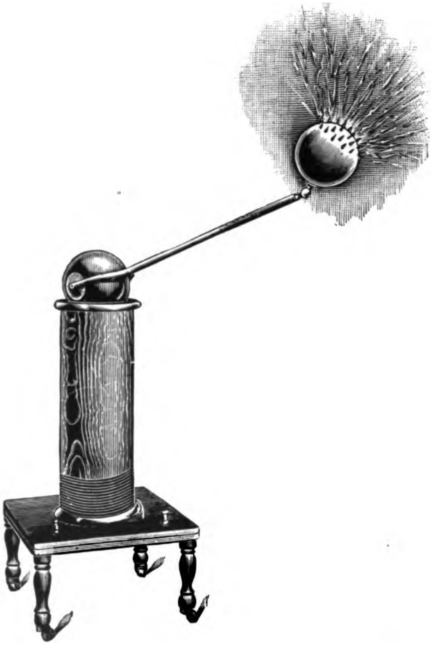
Another experiment which illustrates the flow of high frequency currents from a single terminal is the following: Hold a small piece of platinum in the fingers and allow the spark to pass from the apparatus to the wire. The current passes through the wire as it did the lamp and it is of such strength that the wire is melted and falls in molten globules upon the floor.

There has been considerable discussion of late with regard to what is called the "skin effect" of high frequency currents. Some claim that currents of high periodicity do not penetrate the human body to any appreciable extent, but are confined to the surface. They cite as evidence to uphold their theory the fact that such currents are undoubtedly superficial when conductors of low resistance are employed. Any one applying a powerful frequency spray over the abdomen, and then saying such currents do not penetrate, must be devoid of feeling. The effect is felt all through the region so treated, and is felt to penetrate deeply. Let us look at the matter, however, from the standpoint of the physicist and endeavor to explain this penetration.

If a current of extremely high frequency be passed through a copper wire, there is no doubt but that the current is confined to the surface of the conductor. This is called the "skin effect."

Bjerknes demonstrated this experimentally by means of an iron wire with a coating of copper, and a copper wire with a coating of iron. When the thickness of the coating was greater than a hundredth of a millimeter, the iron wire acted like one of copper, and the copper wire like one of iron. This showed that the currents are confined to a shell whose thickness is the hundredth of a millimeter. In the case of the human body, however, we have a new factor to consider and this factor is ohmic resistance. The human body is not a good conductor of electricity as compared with a metallic wire and hence the action of high frequency currents with respect to a metallic conductor forms no criterion as to their behavior with respect to the human body, which has a comparatively high ohmic resistance.

When employing continuous currents, or currents of low frequency, we have conduction currents through the whole mass of the conductor and none at all in the surrounding dielectric. With high frequency currents, on the other hand, there are conduction currents in the superficial layer of the conductor, none in the interior, and displacement currents in the ether surrounding the conductor.



HIGH FREQUENCY RESONATOR FOR USE ON STATIC MACHINE. FOR DESCRIPTION SEE PAGE 262.

The skin effect in conductors decreases as the resistance of the conductor increases, and at the high resistance attained by the human body there is little doubt that the currents penetrate to the innermost portions of the conducting medium. How high frequency currents accomplish the results they are daily accomplishing, both in this country and abroad, with all sorts of apparatus, is a thing not explained by those who uphold the theory that these currents are superficial in their action.

Allen says, "leaving aside the psychical and suggestive effects which must be admitted to have their useful place in certain diseased states, there still exists abundant testimony vouchsafed by careful and conscientious observers, that high frequency currents are of great utility in the cure of many diseases." Much of the therapeutic value of these currents, however, depend upon the antiseptic character of the quantities of ozone given off along their path, and the best effects are more in evidence therefore, when the glass vacuum electrode is applied directly to mucous surfaces, as in the vagina, urethra, and rectum.

Pruritis, psoriasis, eczema, herpes and urticaria are more speedily relieved by its use than by any of the usual remedies employed in the treatment of these lesions. Warts, moles, nevi and other benign growths of low vitality are successfully retrograded by the high frequency spark, but not so quickly as with negative galvanism. Later observations by myself seem to prove the correctness of statements made by others regarding the action of high freqeuncy currents in nervous diseases, in that those characterized by much irritability are not benefited by this modality, while those manifestly of the depressed type are rapidly relieved.

CHAPTER XLII.

MECHANICAL VIBRATORY STIMULATION.

Every therapeutic agent has done more harm than good before it has settled down to its field of usefulness to be used for that which it is known it will accomplish, and mechanical vibratory stimulation is no exception. A certain enthusiasm is begotten by every new method for the treatment of disease, but the enthusiast always hurts the remedy and himself. Many excellent therapeutic measures within certain limits have been cast aside because of this fact.

The author believes that vibratory stimulation is capable of accomplishing much good, and a good vibrator should constitute a part of the armamentarium of every progressive physician, but he cannot believe that it either "embodies within itself *all* the qualities essential for successfully treating disease" or will ever supplant or equal electricity for imparting normal vibrations to nerves. The simple reason for the latter statement is because a nerve *cannot receive vibratory* stimulation from a source not synchronized or tuned to its own normal rate, and few, if any nerves, will respond to the comparatively slow vibrations produced by mechanical means.

The late Dr. Maurice Pilgrim, in a recent work entitled "Vibratory Stimulation," while attempting to prove the *superiority* of this method over electricity, makes many positive statements that are not justified by physical facts, a *few* of which it is thought best to briefly consider here. It must be distinctly understood, however, that the criticisms are not against the method, but are intended solely to avoid that enthusiasm which such statements are sure to beget.

The quotations following are all taken from Dr. Pilgrim's work in the chapter on "Nerve Stimulation."

"It may very pertinently be asked what the natural stimuli or motive force operating upon nerves really are. The answer can at best be only speculation, because it is not susceptible of physical demonstration." The answer is *not* speculative and is not only susceptible of physical demonstration, but has been distinctly proven *to be electrical* by the most competent observers who have devoted the best years of their lives to this work. That there cannot be chemical decomposition without the generation of electrical energy. That nerve impulses are *electrical* and are produced by the chemical decomposition constantly taking place within the living body.

"Evidently the nervous system must be 'started,' so to speak, by forces outside and independent of the body."

Nervous impulses are *started* within and entirely dependent upon the conditions *within* the body. The ether in a *state of equilibrium* either within or outside the body, does not produce tissue metamorphosis until its level is destroyed—causing a flow—by chemical action or otherwise, which takes place *within* the body.

"When, from any cause, nerves become lethargic or partially unreceptive, to this continually exerted outer 'ether' or stimulus, impairment of organ and function ensues. The impairment cannot be due to any diminution in etheric pressure because, like the oxygen of the atmosphere, that is unfailing and incapricious in its supply. Moreover, were it not so, the whole human family would suffer similar lapses at the same time."

The reason why the whole human family does not similarly suffer at the same time, proves conclusively that the "lapses" were not the result of diminution of etheric pressure *from the outside,* but from inside deleterious influences caused probably by violation of nature's laws. All persons do not live as they should and do not all live alike.

" * * * It is a matter of repeated practical demonstration that pressure *does* impart stimulus to a nerve. For example, light pressure exerted over the pneumogastric nerve along the side of the neck, immediately above the sternum, produces a cough."

This only shows that the *normal* function of the nerve has been destroyed by the pressure and is no indication that *mechanical* stimulus of the same, or any other character, will restore its functions or cure the cough by causing a normal vibratory tone to be established, because few, if any, nerves will *respond* to the comparatively slow vibrations produced by mechanical means.

"Electricity, when applied to a trophic nerve, for example, even though it were capable of introducing a new chemical element or exciting a reaction outside of the processes of ordinary functionation, could not make that nerve perform the work of a vaso-motor or secretory nerve."

What electro-therapeutist ever claimed such a dangerous and absurd possibility, and what enthusiastic advocate of mechanical vibratory stimulation would desire such a result from the use of his machine?

"Dubois-Reymond taught that the nutritional effects depend not on the quantity of the electricity, but upon the variations in the *quantity* and the *suddenness* of these variations. It will be observed that in mechanical vibratory stimulation the desideratum above specified of 'variation in quantity' may be and is provided for by means of the adjustable stroke. The 'suddenness of variations' is also provided for in the rapidity of the vibrations, being in most instruments from 1,750 to 2,500 per minute."

Even an ordinary faradic current will far exceed this, both in "variations in the quantity" and "suddenness of the variations," but when we come to compare either the faradic battery or vibrator to the *Morton Wave current,* they pale into insignificance. In the latter modality the *variations in quantity* are from zero to the full output of the machine and the rapidity of vibration *millions per second.*

The author does not wish to convey the idea that vibratory stimulation is not an excellent adjunct in the hands of the physician, because we have an accumulation of evidence to the contrary. The statement, however, that vibratory stimulation, such as is obtained by the use of the various mechanical devices on the market, can restore a normal vibration to nerves that have lost their normal vibratory tone, we believe to be erroneous.

Vibratory stimulation, like all massage, is irritating. It increases the activity of the skin and acts as an irritant to muscles, producing contractions which cause an increased blood supply, greater temperature and increased nutrition.

By producing muscular contractions it thereby stimulates muscular cell growth. It is, therefore, indicated in the treatment of weak or atrophied muscles and as a stimulant to secretory channels as a substitute for exercise.

In some forms of neuralgia pressure upon the part will allay the pain. In such cases the vibrator will have an excellent effect, but it happens more often that pressure increases pain, in which case vibration will do the same.

In bruises and hemorrhagic infiltration such as ecchymoses, it increases absorbtion and hastens restitution.

The employment of vibratory stimulation *within* the rectum, urethra or the female pelvis, cannot be too strongly condemned, although in many instances it may be used upon the *outside* for the relief of pelvic disturbances.

The number of forms and different makes of vibrators on the market is very confusing to the non-expert. The author uses three forms: one giving vibrations in *all directions,* one with adjustable stroke and one for portable use. The first and second are shown in Figs. 41-42, while the portable one is shown on page 328. The latter also answers well for office use.

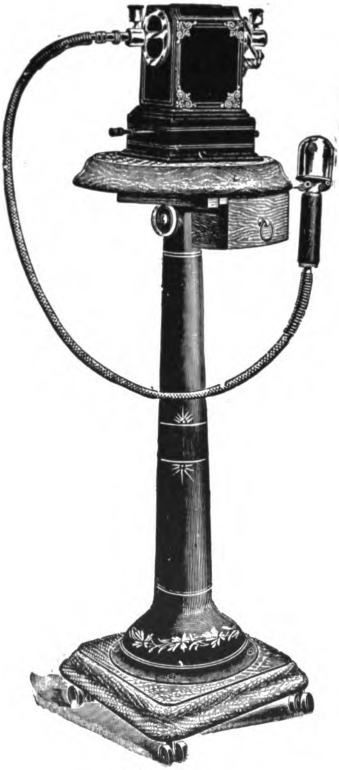


Fig. 41

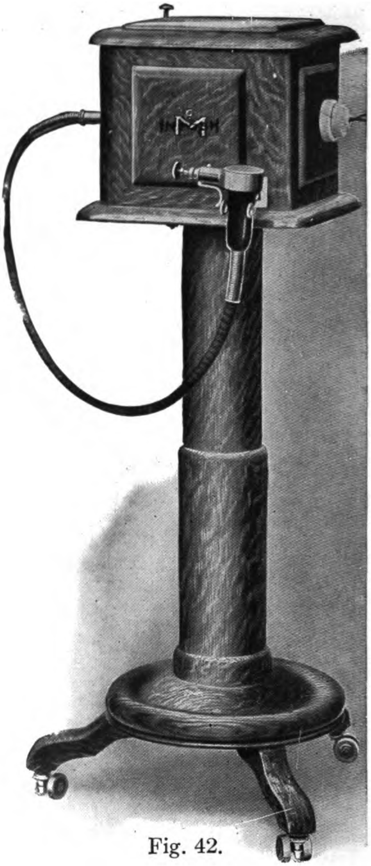


Fig. 42.

THERAPY OF VIBRATION.

Mechanical vibratory stimulation to motor points of the body is very similar in its action to that of rapidly alternating induced currents—faradism—first, by irritation of the nerve, and second, by sedation or loss of function by prolonged application.

Properly applied it is a valuable aid in the treatment of disease, but has been employed so empirically that a few words of advice may not be out of order to the painstaking operator who would get the most good out of his apparatus.

The vibrator does its best work through the sympathetic system, because it must be remembered that the great sympathetic nerve consists of a series of ganglia forming a double chain, extending from its origin within the skull the entire length of the spine, on each side, and sending out branches either directly or indirectly to all the large blood-vessels and every important organ of the body, thus enabling the operator to influence reflexly lesions remotely situated by properly vibrating the various ganglia of this nerve.

When using mechanical vibratory stimulation the fact must be kept in mind that the sympathetic is largely inhibitory in its action, while the vaso motor is the reverse, and that when we *stimulate* the sympathetic the lumen of the blood-vessels is decreased. If, however, the vaso motor is stimulated the muscular walls of the blood-vessels become patulous and the lumen of the vessel is increased. It is for this reason that galvanism does its best work through the vaso motor nerves, because sedation ensues when we apply the *positive,* and the inhibition which the sympathetic exerts has no balancing system, therefore the blood-vessels are contracted; but if, on the other hand, the *negative* pole is applied we stimulate the vaso motor, thus overbalancing the inhibition exerted by the sympathetic, and the vessels are dilated.

To obtain the desired result from Vibration the reader should bear in mind that a slow stroke is *stimulating*, while a rapid stroke produces sedation; that stimulation of the sympathetic means increased inhibition, while sedation of that nerve temporarily destroys its inhibitory power.

As an aid to the better understanding of the subject we have inserted a cut (Fig. 47) showing a portion of the great sympathetic nerve.

A is the superior cervical ganglion, lying in front of the second and third cervical vertebræ. It sends branches to the carotid artery, carotid plexus, cavernous plexus and the heart. A *slow* stroke of the vibrator with firm pressure at this point will cause *stimulation* and thereby a lessened blood supply and relief of stasis in the vessels traversing these parts. If, however, the stroke be very rapid the function of the sympathetic is temporarily destroyed by sedation and the opposite result ensues.

B, the middle cervical ganglion, located opposite the fifth cervical vertebra, sends branches to the fifth and sixth spinal nerves and the thyroid gland. Very slow vibration at this point will decrease the blood supply to the thyroid and lessen an enlargement of that gland. In treating this point the respiration should be carefully observed, because the phrenic is nearly always correspondingly influenced by the close proximity of its motor point.

Slow vibrations over the fourth lumbar vertebra at F will produce contraction of the bowels, bladder and uterus.

Vibration over the hypogastric plexus at P influences the bladder, rectum and sexual organs; causes sexual emotion and, on account of the action produced on the detrusor muscle of the bladder and adjacent parts dependent on the pudendal plexus, cases of enuresis oftentimes yield promptly to vibration over this point (see Case II, page 211).

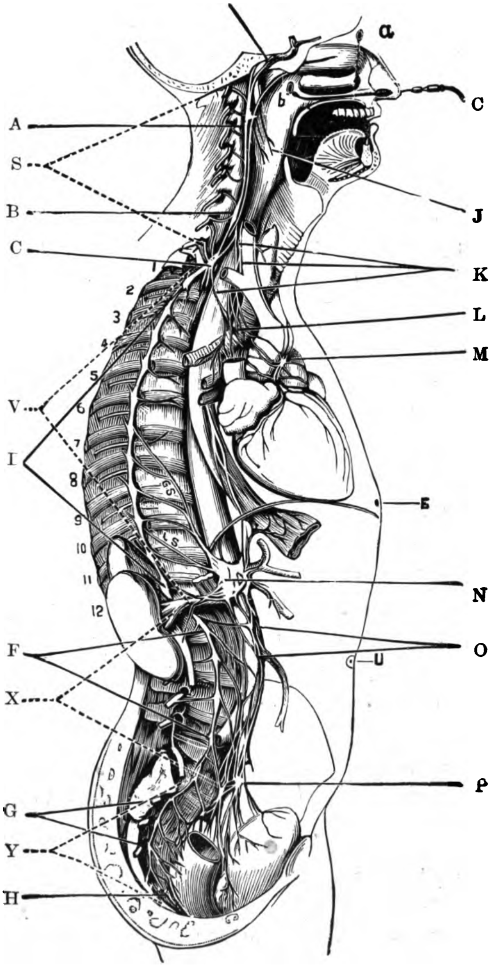


Fig. 47. (After Gray.)

S includes the seven cervical vertebræ.
V includes the twelve dorsal vertebræ.
X includes the five lumbar vertebræ.
Y includes the five sacral vertebræ.

GS and LS mark the location of the greater and lesser splanchnic nerves, which, together with the renal splanchnic, arise from the thoracic ganglia and supply filaments to all the important abdominal viscera. Strong stimulation of these nerves lessens and sometimes arrests the peristalic movements of the small intestines.

The vertebræ may be easily counted by drawing the fingers two or three times down the entire length of the spine, with firm pressure; red spots will mark the projections.

The figures 1 to 12 mark the location of the ribs.

The kidney is most accessible below the last rib on the outer margin of the erector spina muscles. A portion of the ascending and descending colon may be reached on either side of the spine between the kidney and upper edge of the hip bone, outlined in the cut.

As the matter contained in this chapter is already more than is allowable for the scope of this work, and as my readers are supposed to be acquainted with nervous anatomy, a further discussion of this subject is not deemed advisable.

CHAPTER XLIII.

ELECTRO-DIAGNOSIS.

As the character of this work will only admit of a consideration of a minor part of this subject, that part only will be presented which the general practitioner can easily master with only ordinary apparatus and little study.

Heretofore the subject has been presented to the student with such detail and complexity that it has been considered only possible to be used within the domain of the Specialist, but in the simple manner in which I shall endeavor to present it I believe my readers will readily comprehend its underlying principles.

Electricity is a valuable aid in the diagnosis of the following conditions:

1. To distinguish between the different forms of paralysis—central and peripheral.
2. To distinguish between apparent and real death—electro-bioscopy.
3. To tell whether disease is feigned or real (to detect malingerers).

As the first of these has been generally considered in Chapter XXIV of this work, a further discussion is not deemed material, and the reader is therefore referred to that chapter.

The horrible fate of being buried alive is so much to be dreaded that any means which will aid in determining whether life is extinct in doubtful cases should be regarded worthy of a trial. The signs of death which are most generally relied upon are cessation of respiration and the heart's action, a considerable fall in temperature, rigor mortis, the dull cornea, the dilated pupil, non-transparency of the fingers to lamp-light, and, finally, decomposition. These signs are, however, occasionally of doubtful value, since all except the last have been present in cases of trance. Decomposition, when it occurs, is an unquestionable sign of death, but occasionally it is much delayed, especially in cases of poisoning, habitual drunkards and those who die from wasting disease. Althaus claims that "none of these signs are as ready and decisive as faradization, which indicates death with absolute certainty within two or three hours after its occurrence."

Authors are not agreed as to the length of time after death at which the power of the faradic current to excite muscular contractions ceases. Onimus experimented on the body of a criminal, soon after decapitation, to determine the effect of the faradic current on nerve irritability after death. He found that it is lost in the diaphragm and tongue first, and within two hours and a half in all the facial muscles. In the limbs the extensor muscles are the first to die, while the flexors retain their excitability about one hour longer. The muscles of the trunk will answer to faradism five or six hours after death, and the abdominal muscles are particularly tenacious in this respect.

Prof. Rosenthal found that muscular death does not correspond with general death of the body, but follows the latter at a period varying from thirty minutes to several hours; that postmortem electric excitability disappears more rapidly after death from chronic than acute disease.

He reports attending a case of trance, a hysterical woman, who had been apparently dead for thirty-two hours. All the muscles of the face and extremities contracted under the faradic current, therefore he recommended measures for resuscitation. Twelve hours afterward she spontaneously awoke, recovered, and was alive two years after.

From the foregoing it becomes evident that faradic electricity is an indispensable test whether life is extinct in all cases of apparent death, whether from disease or otherwise. When there are several victims, as after accidents, it enables the physician to distinguish the dead from the living, and also the order in which the dead ceased to live.

FEIGNED DISEASE (MALINGERING).

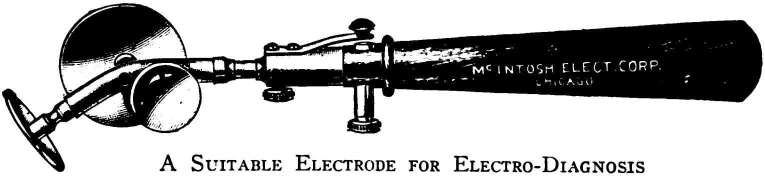
Diseases are frequently feigned for the purpose of exciting sympathy, extorting charity, evading work, and in some instances with a view of obtaining damages after accidents. The faradic current applied to the skin, especially over bony projections, is oftentimes an excellent means of settling the question. It is exceedingly painful, but does no harm.

Paralysis, ankylosis, epilepsy, etc., are favorite diseases with malingerers. In the former disease the symptoms complained of are such as are due to peripheral lesions, as the class of persons who lend themselves to such imposture seldom are sufficiently acquainted with symptoms of nerve or brain disease to successfully imitate them. If, therefore, the muscles respond normally to the faradic current after the patient has complained for two weeks, we may conclude that the case is one of imposition. In cases that are obscure, and where a correct diagnosis is of importance in settling the question of damages, the examination should be conducted as directed for diagnosing obscure cases of paralysis (see page 202).

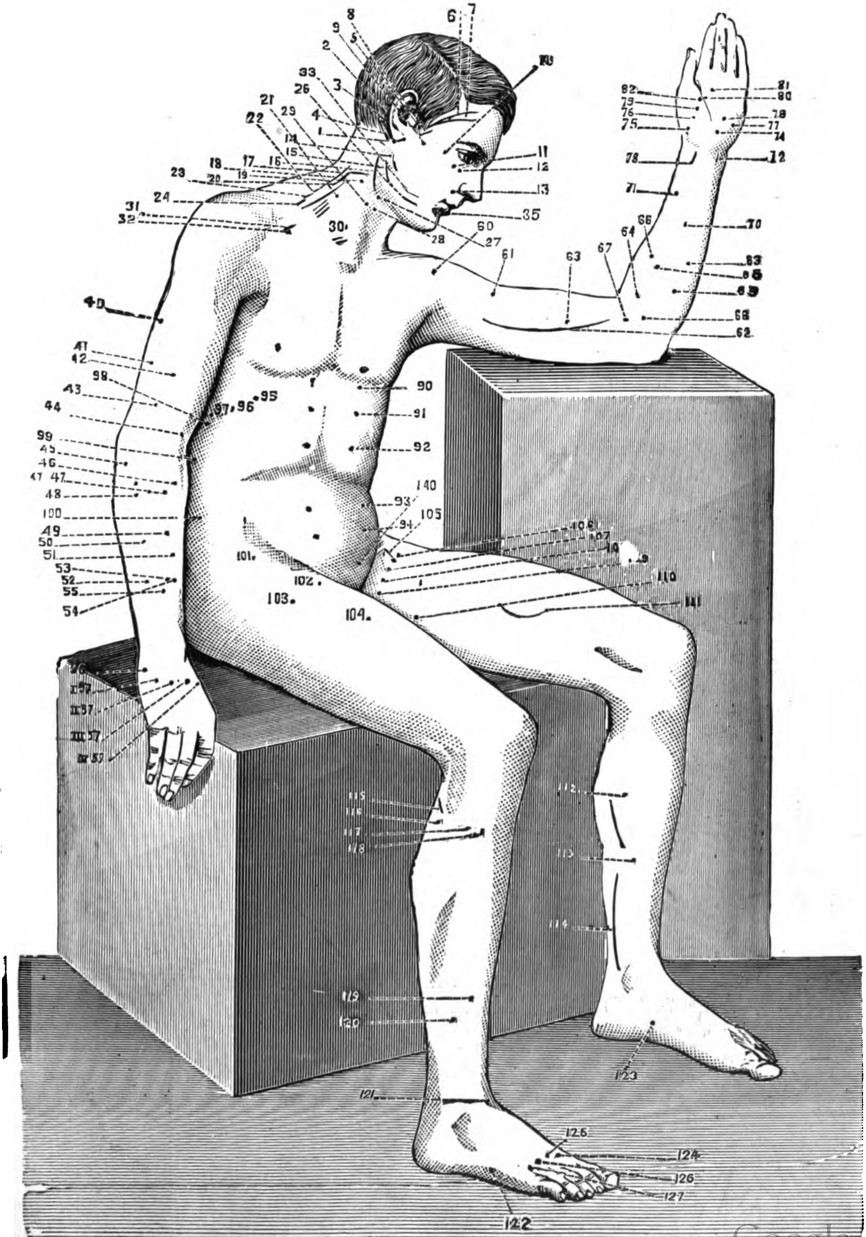
REACTION OF DEGENERATION.

Immediately after a muscle has been injured severely enough to destroy a portion of the motor or mixed nerve, it has been found by Erb that atrophy of the muscular fibers sets in, which may be seen during the second week, and reaches its limit about the fifth or sixth week. At first it ceases to respond to the faradic current, then follows a period when it will react only to a slowly interrupted galvanic current, and finally ceases to react to any form of electrical stimulation. He termed this the reaction of degeneration. It is present in paralysis arising from rheumatism, lead palsy, writer's cramp and telegraph operators, etc. In those difficult cases after railway and other accidents, when the injured demand compensation for damages, the existence of the reaction of degeneration would be a fact of vital importance in favor of the applicant, as it would indicate that he was suffering from a serious injury to the nerves. Such a demonstration in a court of justice is more conclusive than any amount of authoritative opinion.

What has been here written regarding electro-diagnosis is intended more for the guidance of the general practitioner as to the treatment and prognosis of his own cases than for the medico-legal expert. A further consideration of the subject must necessarily deal with "quantitative and qualitative" changes, various symbols and formulas, which might be the means of confusing the busy physician who has not time to devote to these more complex phases of the subject.



A SUITABLE ELECTRODE FOR ELECTRO-DIAGNOSIS
WITH THREE INTERCHANGEABLE DISCS.



Motor Points (After Myer).

1—Facial nerve at its exit.
2—Auriculo-posterior branch of facial nerve.
3—Branch of facial to occipito-frontalis muscle.
4—Branch of facial to tragicus muscle.
5—Auriculo-anterior branch of facial.
6—Branch of facial supplying frontalis muscle.
7—Facial branch to corrugator supercilii.
8—Facial branch to orbicularis palpebrarum.
9—Facial branch to zygomaticus major.
10—Facial branch to zygomaticus minor.
11—Facial branch to levator labii superioris.
12—Facial branch to compressor nasi.
13—Facial branch to levator labii sup. proprius.
14—Buccal branches of the facial.
15—Infra maxillary cutaneous branches.
16—Subcutaneous branches of colli super.
17-18—Branches of spinal accessory.
19—Affects the platysma myoides.
20—Branch from cervical plexus to lev. Aug. scap.
21—Phrenic nerve. Respiration.
22—Dorsalis scapula nerves.
23—Posterior thoracic nerve.
24—Supra-scapular nerve.
26—Branch of facial to triangularis menti muscle.
27—Hypoglossus nerve.
28—Motor point of omo-hyoid muscle.
29—Motor point of sterno-thyroid muscle.
30—Motor point of sterno-hyoid muscle.
31—Outer cord of brachial plexus.
32—Anterior thoracic nerve.
33—Branch of facial to depressor labii inf.
40—Branch of radial nerve to triceps.
41—Radial nerve.
42—Radial branch to brachialis ant. muscle.
43—Radial branch to supinator longus muscle.
44—Radial branch to exten. carpi rad. long.
45—Radial branch to anconeus quartus.
46—Nerve to extensor carpi rad. brevior.
47—Nerve to extensor com. digitorum.
48—Nerve supplying the extensor carpi ulnaris.
49—Motor point for abduct. pollicis longus.
50—Motor point for exten. minimi digit. prop.
51—Motor point for extensor digiti.
52—Motor point for extensor indicis prop.
53—Motor point for extensor pollicis longus.
54—Motor point of extensor pollicis brevis.
57—Motor point of interossei externi.
60—Branch of ant. thoracic nerve.
61—Musculo-cutaneous nerve.
62—Median nerve.
63—Motor point of brachialis int.
64—Motor point of pronator teres.
65-66—Points of flexor digitor. sub.
71—Branch of median to pollicis longus.
72—Branch of ulnar to palm of hand.
73—(See 62.)
74—Motor point of volaris profundus.
75—Motor point of abduct. pollicis brevis.
76—Motor point of opponens pollicis.
77—Motor point of abductor digiti min.
78—Motor point of flexor digiti min.
79—Motor point of flexor pollicis brevis.
80—Branch of ulnar to abductor pollicis.
81-82—Branch of median supplying the lumbricalis.
83—Motor point of flexor digitor.
90 to 94—Motor point of rectus abdom. ext.

95 to 98—Motor point of obliquus abdom. ext.
99—Motor point of transversus abdom.
100—Motor point obl. abdom. inter.
101—Branch of crural to tensor fascia lat.
102—Branch of crural to rectus femoris.
103—Motor point of vastus ext.
104—Motor point of vastus and rectus.
105—Crural nerve.
106—Branch of crural to M. Sartoris.
107—Motor point of pectineus muscle.
108—Motor point of abductor brevis.
109—Motor point of abductor longus.
110—Motor point of gracillis.
111—Motor point of vastus int.
112—Motor point of soleus.
113—Branch of tibialis to flexor digitor.
114—Tibial nerve.
115—Peroneal nerve.
116—Popliteal nerve.
117—Motor point of ext. digitor com. long.
118—Motor point of tibialis anticus.
119—Motor point of ext. hallucis long.
120—Motor point of peroneus tert.
121—Motor point ext. digitor com.
122—Motor point of abductor digit. min.
123—Motor point of hallucis.
124-127—Motor points of interossei ext.
140—Obturator nerve.

The motor point of the sciatic nerve (not shown in cut) lies between the trochanter major and tuber. ischii.

CHAPTER XLIV.

THE ELECTRO-STATIC WAVE AND NEURITIS.

The medicinal treatment of this lesion has been productive of such poor results, and we receive so little encouragement from the best text books upon the subject, that the physician will hail with delight an electrical modality that has proven itself capable of permanently relieving many of the worst cases.

This disease generally starts with an inflammation of the nerve sheath; an exudate is thrown out around the nerve which in time shrinks and hardens, causing pressure upon the nerve.

The principal diagnostic difference between this disease and a simple neuralgia, is that in the latter the pain is more diffused and constant, while in neuritis we have painful spots along the course of the nerve, which are rather intermittent in character.

It becomes evident then to only a casual observer that medicine will not reach the trouble.

I have had many bad cases of brachial, sciatic and circumflex neuritis entirely relieved in from thirty to forty days by the use of the Morton wave current. This form of static electricity is not new, but is the same as that described about eight or ten years ago under the name of "alternating potential," but its uses were not so well defined at that time.

The "electro-static wave" or "Morton wave current" produces deep and painless massage, thereby not only causing the absorption of the exudate being thrown out, but softening the adhesions that have already formed, so they may be taken care of by the absorbents.

The first treatments naturally cause the pain to be made worse, and this oftentimes discourages the operator, who thinks the trouble is being made worse. It is often hard also to induce patients to continue the treatment, because they think they do not improve rapidly enough.

It is therefore necessary to impress upon them the fact of the stubbornness of the trouble and the length of time necessary for the physician to produce visible improvement.

Unfortunately there is some confusion among operators regarding the method of administering the "wave current," some advising that the Leyden jars be *attached,* while others give the treatment with jars *removed.*

In giving treatment for a neuritis we require deep and painless muscular contractions, and this can only be accomplished when the Leyden jars are *attached.*

While it is true that we get a most powerful tonic effect on the nerves with the jars removed, the muscular contractions with such modality are not only less but more painful, and besides, the spark intermissions between the prime conductors cannot be properly controlled and are too rapid for ideal massage, at times even producing a tetanic contraction, which only aggravates the trouble.

With the jars attached we are able to perfectly control the number of sparks and get a deep and painless massage which in time will cause the complete absorption of the exudate and adhesions.

In so-called "trifacial neuralgia"—which is not a neuralgia, but has all the earmarks of a neuritis, I have had the most remarkable results even after section of the facial nerve had been done. In one of these cases a complete symptomatic cure was made in two months, although the disease was of eleven years' standing.

In conclusion, the technique is as follows: The jars are *attached* and their *outer* coating joined by closing the switch. [In most static machines this is accomplished by placing the switch pointer on "spark."]

A ball electrode with long insulated handle is attached to the *inner* coating or *top* of one of the jars, and, if the case is one in which the patient can hold the electrode himself, I always allow him to do so; the *inner* coating or *top* of the other jar is "grounded" by connecting to a water pipe or gas fixture.

The machine is now started, with the balls on the prime conductors *actually touching* each other, and the patient instructed to apply the electrode *firmly* to the painful spot.

The operator then carefully separates the prime conductors until the limit of tolerance of the patient is reached, regulating the speed of the machine to give about three or four sparks per second.

If the treatment is given about the face a spark gap of from one-half to three-fourths of an inch is about all that can be tolerated.

I have had most excellent success in the treatment of many cases of deafness due to a partial anchylosis of the ossicles by this method. In these cases I use a double ear electrode with wet cotton twisted upon the distal ends and inserted as far as possible into the ears—not forcing the cotton, but *pointing* it so it will enter easily. The spark gap in this instance will be hardly more than one-fourth of an inch.

In all delicate operations, as the preceding, where the jars are to be *attached* I use the small jars.

In all cases such as neurasthenia, or where it is only necessary to restore a normal vibration to nerves, I do not employ the jars, when, of course, it makes no difference as to the position of the switch pointer, but in all cases where massage or promotion of absorption is required I always use the jars.

While most operators agree that it makes no difference to which pole of the machine the patient is attached, some are of the opinion that the positive side of the machine should be the one leading to the patient, so as long as it makes little difference we may as well take the benefit of the doubt and use the positive side for this purpose.

CHAPTER XLV.

CATAPHORIC APPLICATIONS OF THIOSINAMIN.

THE REMOVAL OF SCAR TISSUE.

Many physicians who have had but little success in the use of thiosinamin for the removal of scar tissue, will, no doubt, be glad to know that the same medicament cataphorically employed is quite successful. Not only will the process given in this article remove scars, but is equally potent in treating strictures, glandular enlargements, old lacerations of the cervix uteri and chronic middle ear deafness due to partial anchylosis of the ossicles.

Thiosinamin or allyl sulphocarbamide is a synthetic preparation made from artificial oil of mustard (allyl sulphocyanate) and appears in the market in the form of colorless crystals with faint garlic odor and bitter taste. The best preparation is made by Merck. It is not expensive. Therapeutically it has a peculiar selective action for scar tissue, and has been given internally with marked benefit on strictures in various canals of the body and corneal opacities. Before I began to use the medicine cataphorically my experience was limited to probably a half dozen cases of unsightly scars about the face. These were removed by the application of a 10 per cent ointment, the base of which was lanolin. Another case, however, worthy of mention, was the removal of a bad scar on the neck, due to an operation on the median lobe of the thyroid gland. This case was treated by the administration of grs. 1½ of the medicine in capsules *ter in die* in connection with the ointment rubbed in twice daily. A perfect result was obtained in about two months.

Cataphorically applied, the medicine is much more active than when administered internally, or by inunction.

While thiosinamin is easily soluble in alcohol and ether, such solutions are not suitable for cataphoric purposes on account of their resistance. It dissolves slowly in water, but becomes much more soluble by the addition of glycerin. The best solution I have found for cataphoric purposes is as follows:

Thiosinamin (Merck)	grs. xx
Glycerin	ʒii
Aqua	ʒvi
M. Sod. Chlor	grs. v

TECHNIQUE.

The metal of which the electrode is composed should be as nearly non-oxidizable as possible, because, being used on the anode, the oxygen evolved not only corrodes the electrode, but deposits a salt of the metal of which it is composed in the tissue, which seems to greatly interfere with the action of the thiosinamin. Platinum is the best metal for the electrode, but it is expensive and I have found that pure block tin answers the purpose admirably.

The best connector for attaching the block tin electrode or in fact, for any similar purpose, was devised by the late Dr. W. J. Herdman, and is sold by dealers under the name of the "H2" connector.

A piece of absorbent lint a little larger than the scar to be treated is saturated with the solution and placed upon the spot. Now cut out a piece of block tin a little smaller than the sheet of lint, and after fixing it in the connector attach it to the conducting cord from the positive side of a galvanic battery and apply firmly to the lint. The negative terminal of the battery may be a well moistened pad as large as the hand, placed upon any convenient part. The current strength will depend upon the size of the active surface of the electrode, but may be stated at from three to twenty milliamperes, allowing the sitting to continue ten minutes.

The next treatment should not be given until the skin overlying the scar becomes dead, and can be readily peeled off. This generally takes place in three or four days.

CERVICAL LACERATION.

In searching for the cause of many distressing lesions accompanied by pain in the head, sleeplessness, extreme nervousness and dysmenorrhœa, old lacerations of the cervix uteri are almost invariably overlooked. Surgical procedure for removal of the scar tissue is only partially successful, as the granulation and healing of the incisions made by the operator is oftentimes productive of nearly as much scar tissue as the knife has removed.

That we are able to employ cataphoric methods as curative factors with success in cases of old lacerations of the cervix, and that this treatment means a distinct progress in gynecology, no one acquainted with the facts can deny.

In the past I had some degree of success in softening up and causing absorption of the scar tissue by means of the negative pole of a constant current, but the polar action was apparent also on the sound tissue, which was often excessively cauterized and healed with difficulty.

As has been stated in the first part of this chapter, thiosinamin has a selective action for scar tissue, and, when used cataphorically, it seems not to affect the sound tissue, the latter being only temporarily hardened by the polar action of the positive pole.

TECHNIQUE.

The electrode shown in Fig. 48 is composed of a metallic staff nine inches long, insulated with hard rubber, on the distal end of which is fastened a piece of No. 20 iridio-platinum wire which protrudes from the end of the staff $\frac{7}{16}$ inch. The staff is surmounted by a hollow ball also of hard rubber which is $\frac{3}{4}$ inch in diameter and perforated with a number of small holes.

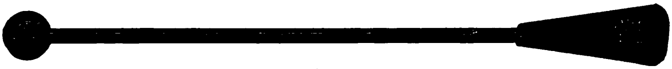


Fig. 48.

The hollow ball is now filled with absorbent cotton, and, by means of a medicine dropper, is saturated with the same solution of thiosinamin as given in the beginning of this chapter. Before screwing the ball on the staff it is always best to wind a little cotton on the platinum point, wetting it also with the solution.

Place the usual wet pad upon the abdomen and fasten it to the conducting cord from the negative pole of a galvanic battery. By means of a vaginal speculum expose the os, and having attached the electrode to the positive pole apply the ball firmly to the orifice.

A current strength of from 15 to 25 milliamperes may be maintained for ten minutes, and the sitting repeated three times per week until the scar tissue has entirely disappeared and the os soft and elastic to the touch.

CHAPTER XLVI.

PRACTICAL LIGHT THERAPY.

The author has for many years had much faith in the therapeutic qualities of light, so much so that twenty-five years ago he had constructed a light cabinet containing a number of different colored lights.

His experiments were conducted with the assistance of Dr. Sudduth, a prominent psychologist of that time, and although they were successful in the main, had to be discontinued on account of adverse criticism of the profession. We only got so far as to observe that the patient would perspire in half the time under the influence of red light, and that blue light was a depressant. Thus another good therapeutic agent was placed in temporary oblivion by the adverse criticism of those who did not understand it.

Light is such a common force in nature that, like the air we breathe, we have, in the common affairs of life, failed to recognize in it one of the most vital therapeutic agents in the entire realm of physical forces.

We are familiar with the wonder-working powers of Sun Light, but we have failed to recognize the Electric Light as resuscitated Sun Light. We have seen the earth, brown and sear in early springtime, quickened to life and beauty; the tiny buds burst their prison cells and develop into flower and fruitage; the fetid odors of putrescence disappear—and all under this magic influence of the Sun's rays. But, somehow, we limit the Electric Light to its luminous qualities, forgetful that in it we have real "Bottled Sunshine" under our absolute control, ready for application when desired, and with the widest range of adaptation.

In fact, in the modern adaptation of Light Therapy we have actual Sun Light resuscitated from the energy long stored in the lumps of coal used as fuel. This latent energy in the coal, liberated in the furnace and transformed in the dynamo, is flashed forth again in radiance from the electric arc or incandescent filament on its mission of service to the world. In other words, that subtle force—that potent silent process that tints the petals of the lily and the lilac, that scents the rose and the jasmine, that flavors the ripening fruit in the orchard, or paints the rocks by the seaside—is one and the same of Nature's forces, whether at work in the flower garden, on the sands of the seashore, or in the modernly equipped medical office or institution.

Radiant Light and heat is the most simple, practical and economic of electrical modalities for office as well as institutional practice.

Less technical training is required, and little or no danger attends its use even by a novice, while the most gratifying results reward intelligent efforts. Perhaps no other physical agent has made so rapid and favorable progress with all classes of practitioners as has Light Therapy during recent years. Light Applications are indicated in a larger class of cases, the treatments are more simple to give and the results are far greater than is generally supposed. In fact, a new page in the evolution of physical therapy is about to be written in the development of an universal interest in this simple effective agent.

PHYSICAL QUALITIES OF LIGHT.

A careful study of the physics of Light reveals many peculiar characteristics which adapt it for making thermal and other therapeutical impressions not so well accomplished by any other means.

The Electric Light penetrates the tissues much as does the X-ray, although to a lesser degree. Sun Light and Electric Light are both simply radiant energy, possessing no heat until transformed into such in overcoming resistance in penetrating opaque bodies, just as the electric current develops heat in overcoming resistance in its circuit through a poor conductor. A ray of Sun Light penetrates the earth's crust until completely transformed into heat, warming the earth to a considerable distance below, and stimulating into action all the dormant forces of nature.

In exactly the same manner, a ray of Light from an incandescent filament penetrates the tissues of the human body until radiant energy is transformed into heat energy by overcoming resistance in its passage through the tissue structures, inducing a marked cellular activity. It is now generally admitted that the incandescent rays penetrate the tissues to a depth of four to six inches. A simple experiment will demonstrate the penetrating power of light rays even through bony structures. Place a good pocket searchlight in the mouth with the lamp bulb pressing against the roof of the mouth and, in a darkened room, notice the illumination of the frontal sinuses, or place the lamp in the palm of the hand and trace the outline of the bones. The advantages that the penetrating qualities of Light give to it as a therapeutic agent compared with those possessed by "dark heat," as hot water bottles, electric pads, etc., are:

1. The heat is produced *within* the body instead of being applied at the *surface only*. Thus, the processes of metabolism are influenced in the most positive manner, while the depressing effects of continued applications of *heat* to the *surface* of the body (particularly in the general bath) are entirely overcome.

2. The hyperemia produced is not merely a dilatation of the surface vessels, but the deeper subcutaneous tissues are gorged with blood, relieving internal stasis.

3. During the light bath, the blood and lymph vessels, with their vital fluids flowing through them, are brought under the most powerful of all vital stimulants—the penetrating thermic rays. The blood stream is cleansed and oxygenized for the processes of nutrition and the entire physical economy receives the vital impulses of the light waves.

Speaking of the value of hyperemia as a therapeutic agent, Dr. William Benham Snow states: "Where hyperemia is present, as induced by a natural physical stimulus, there is (1) increased nutrition through the tissues; (2) the activity of the cellular elements is also stimulated, with a consequent increase in local metabolism; and (3) a greater number of phagocytes are carried in and out through the tissues. Elimination, phagocytosis, and the tissue producing processes of the body are thus accelerated."

RADIATING QUALITIES

When a hot water bottle, soapstone, electric pad or other heated substance is brought in contact with any portion of the body heat is transmitted by direct conduction, but when Light applications are made the lines of radiant energy flow out from the generator, enveloping the whole or any portion of the body of the patient, without direct contact with any hot or burning surfaces, thus avoiding all dangers of discomfort to the patient.

In caring for a patient in bed, especially in cases of subnormal temperature where uniform temperature is required for several hours or even days continuously, rays of Light from the radiant bed-warmer bathe the body of the patient without contact with any hot surface and maintain an even distribution of heat throughout the bed.

COMPOSITE FEATURES.

The various bands of the spectrum possess distinct therapeutic qualities.

These bands may be isolated by proper screens for special purposes, or combined in White Light as desired.

The physiologic action of these different rays is well defined by Dr. George Starr White as follows:

(1) Red weakens the processes of both assimilation and dis-assimilation.

(2) Green light stands lower than white in regard to the accumulation of nitrogen as well as to qualitative metamorphosis. Destructive changes proceed more vigorously in green light.

(3) Yellow and violet lights induce the maximum of energy in all the vital processes, more complete metamorphosis prevailing under the influence of violet light.

(4) Darkness causes a diminution in the exchange of nitrogen in the body and it instantly diminishes in the daily amount of urine.

(5) The full visible spectrum gives general therapeutic results. This can be proven clinically.

PSYCHIC EFFECTS.

Every physician recognizes the value of psychic impressions, particularly in the case of certain classes of patients.

No physical force or phenomenon has been capable of producing such marked effects upon the mental state as Light. Crime, vice and disease thrive best in darkness. Light dissipates gloom and despondency and begets life, courage and determination.

Different colored lights also make distinct mental impressions. Red light is stimulating, and if long continued becomes a positive irritant; blue is sedative, and if prolonged produces a state of docility.

CHEMICAL AND BACTERICIDAL ACTION.

The chemical qualities of light have been supposed to reside principally in the higher frequencies of the spectrum. All are familiar with the chemical action of these frequencies in decomposing the salts of silver on the photographic plate, and in producing erythema, or "Sun Burn."

Recent observations now indicate that other rays have similar action upon various solids and chemical substances, rendering the red, yellow, green and other bands of the spectrum of special value in their physical effects upon metabolism.

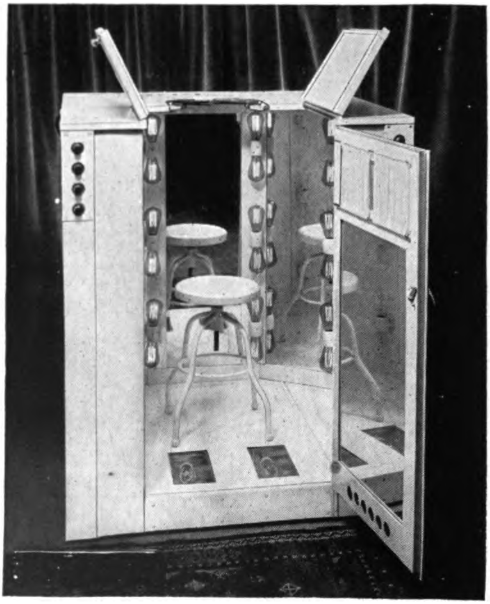
PHYSIOLOGIC EFFECTS.

The first effect of Light rays to be noticed upon body tissues is a marked dilatation of the peripheral blood vessels. The hyperemia thus produced is much more persistent than that resulting from heat applications alone. Through the deep penetration of the light rays the subcutaneous tissue is also correspondingly influenced, producing a marked flow of blood to the surface, relieving internal congestions.

The next result of Light applications to be noticed is a stimulation of the glandular tissues of the skin, producing active diaphoresis. High temperature is not essential to active sweating in the Light Bath. Light rays stimulating the sweat glands produce profuse diaphoretic action in less time and at a lower temperature than any other method known in physical therapy.

THERAPEUTIC ACTION.

For convenience Light applications may be divided into four classes: (1) general, (2) local, (3) "short intensive," and (4) "mild prolonged." The adaptation of these various methods of application will be referred to later in this chapter.



MODERN ELECTRIC LIGHT BATH, SHOWING OCTAGONAL ARRANGEMENT OF LAMPS, CUTOUT BOXES, REFLECTING PANELS, THERMOMETER CASE, FRONT DOOR VENTILATORS AND A SANITARY COLLARETTE. A COMBINATION WHICH PRODUCES A THERAPEUTIC INSTRUMENT OF GREAT VALUE IN LIGHT BATH TECHNIC.

The Light Bath acts as an eliminative agent in the following ways:

1. By the emunctories—relief of internal venous stasis permits the liver, kidneys and bowels to take up their work of elimination in a normal manner.

2. By diaphoresis, through action of light rays upon the

glandular tissues of the skin and by reflex action through the spinal centers.

3. By increased oxygenation of the blood at the surface of the body.

4. By increased respiratory and heart action.

Light rays penetrate the skin much as do the sun's rays the panes of glass over a hot bed, producing an "accumulation" of heat in the subcutaneous tissue the same as heat is accumulated under the glass frames. This accumulation of heat within the body tissues has a positive action upon metabolism and renders the Light Bath the nearest known substitute for physical exercise.

Dr. Leonard Manning (Chicago) reports the remarkable results of elimination by the Light Bath in handling cases of lead poisoning among the employees of the National Lead Works. In this institution a new type of ventilated Light Bath has been installed, and, in the sections where lead poisoning has heretofore been almost constant, the men are required to take the Light Bath twice a week the same as any other duty performed. As a result of this régime lead poisoning symptoms have entirely disappeared and the working power of the men greatly increased.

Stimulation.—As a general systemic tonic, when associated with proper cooling applications, the Light Bath has no equal in therapeutics.

Light rays are a vital stimulant to animal and vegetable cells alike. We have seen the tiny garden seed quickened in early springtime to leaf, bud, flower and fruitage under the vitalizing power of Sunlight.

During the general Light Bath the animal cells of the entire physical economy are brought under this same stimulating influence, accelerating the metabolic processes to a remarkable degree. Respiration is quickened, heart action is accelerated, the digestive functions are improved, and the liver, kidneys, bowels, etc., all receive the vital impulses, whipping them up to normal action. Major George W. Crile, in a recent report of his work in charge of the Lakeside Unit in France, said:

"Last year at the American Ambulance in Paris, Dr. Winchester Dubouchet called my attention to the value of electric light in the treatment of infected wounds. . . . . We gave the method a trial on my service and secured so much better results than by the use of dressings that, upon the return of the Lakeside Unit from France, we introduced this treatment in Lakeside Hospital and observed its effect upon various types of wounds.

"What the experiences of war had proved to military surgeons soon became obvious to us, i. e., that little, if any, advance in the treatment of infections had been made in many years. We soon realized also that the real reason for the efficiency of the electric light treatment lay in the fact that Nature's own method of promoting repair is thus produced artificially, as is demonstrated not only by Chaput's successful substitution of electric light for sun baths, but far more strikingly by the remarkable facility with which wounds heal in desert places. For example, in Arizona, where the air is dry and rare and the rays of the sun are direct and strong, the carcass of an animal does not rapidly decompose. In this region, tuberculosis is easily cured, and tubercular lesions of the skin and superficial parts heal rapidly."

Derivative Effects.

Most diseased conditions are associated with a disturbance in the normal balance of the circulation—a congestion in one part of the body and an anemic condition in another.

To maintain a normal balance in the blood supply between the skin and muscles on the one side and the liver, kidneys, spleen, bowels and other vital organs on the other is a consideration of greatest importance to every physician in handling his cases.

Frequent applications of the Light Bath tend to a permanently relaxed peripheral circulation and improvement in the general nutrition. This is, without doubt, the most important consideration of the *Light Bath,* and the keynote of its therapeutic value, relieving a long list of acute and chronic conditions associated with stasis, as constipation, nephritis, torpid liver, gastritis, dysmenorrhoea, peritonitis, etc.

Sedation.—The value of the Light Bath in relieving pain, insomnia, hypertensions and the various neurotic conditions has been proven in the handling of many thousands of cases reported by men recognized as authority in physiologic therapeutics.

These sedative effects of the Light Bath may be classified as follows:

(1) The reflex inhibitory action of light upon the nerve centers through stimulation of the cutaneous nerve endings.

(2) Diverting blood from congested areas of the skin, muscles and extremities, thus relieving pressure upon nerve centers, traumatic lesions, etc.

(3) Elimination of toxic poisons which irritate the nerves and vitiate the blood.

LOCAL APPLICATIONS.

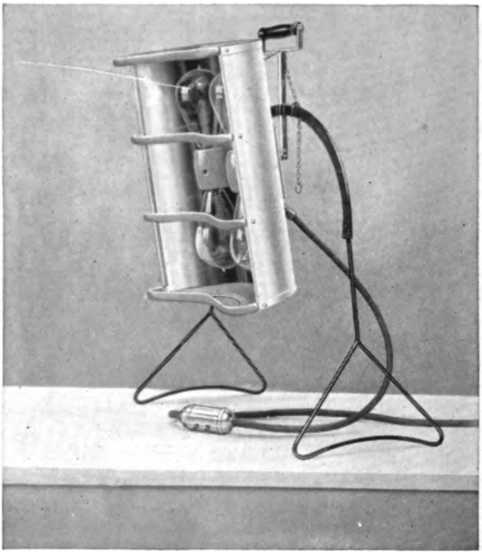
The evolution of "Local Applications" from the days of "blistering," "cupping," "bleeding," etc., to the present time, makes an interesting page in medical history.

Every physician, whether specialist or general practitioner, has frequent demand for the most effective means of Local Applications for the relief of pain, congestion, infections, sprains, dislocations, hypertension, etc., and to increase local nutrition and stimulate reflex functional activity in sluggish organs.

Hot water bottles, electric pads, soapstones, vibrators, high frequency currents and radiant light and heat have all been requisitioned for service in this important field of therapeutic ministration.

Light possesses many physical qualities which, when properly understood, readily give it first place among natural agencies for therapeutic applications. In fact, in these days of progress few physicians are to be found who have not experienced some of the splendid results of Radiant Light and Heat for the special purposes mentioned above.

In a brief chapter of this kind, it will be possible only to



Applicator, Showing Easy Adjustment, Two Circuit Switch, Etc.

merely outline the physiologic effects sought by these procedures.

Local applications are made to produce one or more of the following effects which indicate the technic to be employed in each individual case:

(1) Deep, effective, hyperemia for relief of localized congestions.

Light rays give a more persistent dilatation of the surface vessels than any other means of producing hyperemia known, and hence are of the greatest value for relieving all local congestions, such as pelvic, renal, liver, gastric, pulmonary, etc.

(2) Increased Leucocytosis for combating local infections, such as ulcers, abscesses, etc.

The even distribution of Light and heat over the entire area under treatment with the Applicator, permits continued applications for the deep penetration essential to effective hyperemia in cases of infection or other lesions in deep tissue structures. Frequent dashes of cold (ice, if possible) increases local resistance and contracts vascular tissues, forcing out the vitiated blood, to be quickly replaced by pure blood, under action of the intensive light rays for the active process of leucocytosis.

(3) Improved local nutrition for healing of wounds, traumatic lesions, etc.

The value of these treatments as a post-operative procedure, if generally understood, would soon bring them into universal use.

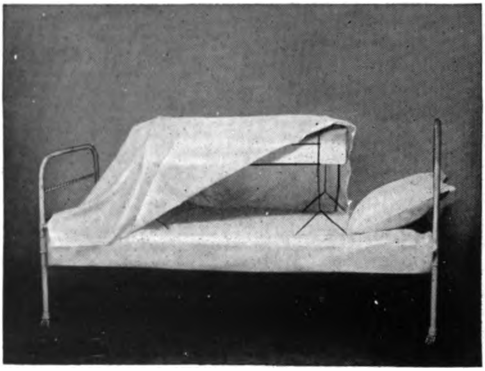
(4) Inhibitory action for the relief of pain.

The thermal rays have a peculiar inhibitory action in lessening nervous sensibility and functional activity of overworked organs, making it one of the most valuable physical agents known for the relief of pain.

Applications are usually made intensive, stroking the surface and giving a dash of ice at the close and at intervals if prolonged.

(5) Reflex effect of local applications upon localized blood supply.

As is now well understood, every cutaneous area is reflexly related to some definite internal area, so that by applications of heat and cold made scientifically to these reflex areas, the blood supply to any portion of the body may be controlled absolutely.



An Ideal Applicator for Giving an Effective Sweat in Bed, or for the Mild, Prolonged Light Bath for the Correction of Subnormal Temperature Resulting from Shock, Etc.

The cold applications stimulate reflex constriction of the congested areas, while the light applications to the extremities or surface areas divert the blood to the general circulation and the congestion is thereby relieved.

(6) Marked functional activity induced in the vital organs reflexly connected with the cutaneous centers.

In no other way is it possible to stimulate or inhibit functional activity of the vital organs more effectively than by the application of light and heat, properly combined with cold, to these local areas for definite reflex effects.

CLINICAL TECHNIC.

While Light Applications have few contra-indications and negative results are practically unknown, proper methods of application are as essential to best results as in the handling of any other physical agent in therapy. The following outline may be regarded as suggestive:

THE GENERAL LIGHT BATH.

The method used depends upon the results desired, except that in *all* cases the ventilators should be open sufficiently to give a free flow of fresh air through the cabinet.

Tonic Effects require only brief applications sufficient to "pink" the skin and start activity of the sweat glands—an average of three to five minutes and immediately followed by a cool spray, alcohol rub or other suitable cooling application for full daily tonic reaction. The short morning Light Bath is the daily tonic supreme.

Derivative Effects are best obtained by continuing the bath only to the point of *full* sweat (five to eight minutes at 90° to 100° F.), and followed by a gradual cooling for full revulsive effect. The hyperemia produced is thus rendered much more persistent. The temperature of the cabinet should not exceed 110° F. Control temperature by ventilation and not by turning off lamps during bath.

Profuse Diaphoresis without enervation is obtained in less time and with greater enjoyment in a well ventilated cabinet, using 60-watt tungsten instead of carbon lamps. Temperature should not exceed 110° F.

"Mild Prolonged Applications."—All types of cabinets and applicators are employed for this class of treatments.

"Mild prolonged" applications are given for the following special purposes:

1. To combat subnormal temperature resulting from shock and in other debilitated conditions.
2. For persistent hyperemia as a derivative measure for relief of congestions and inflamed conditions, such as rheumatism, arthritis, etc.
3. For sedative and quieting effects in case of hypertensions and other neurotic states.

LOCAL APPLICATIONS.

For intensive effects, applications should be made hot as possible without discomfort and may be prolonged from fifteen minutes to one hour.

"Mild prolonged" applications may be continued from an hour to a period of several days. The temperature should not be high enough to produce sweating.

NEW EQUIPMENT.

It has been the author's purpose for many years to give to his readers and students not only the principles of physical therapy, but, also, the most modern and practical means of equipment for doing the work.

Light therapy in the past has languished because manufacturers had not studied the subject scientifically, and their goods were crude and impractical.

The equipment shown upon these pages is scientifically constructed and is presented here for that very reason.

The General *Light Baths* are sanitary, have widest range of control, and are properly ventilated, providing not only a flow of fresh air through the cabinet, but a circular flow of air *within* the cabinet, so that the upper part in the region of the heart never becomes hotter than the feet. By this means the temperature in the cabinet may be controlled within the "neutral zone" without diminishing the lighting power of the cabinet.

The applicators are all constructed to reflect light in parallel rays, so there are no "hot spots" to burn the patient and produce discomfort.

They are adjustable for applications to all parts of the body and in all positions; thermally insulated for protection of patient and bedding; compact and light to handle when not in use, etc.

Taken together, the cabinets and applicators constitute the most complete series of appliances for the scientific use of Light and heat obtainable and make the subject of Light Therapy practical for all.

CHAPTER XLVII.

PHYSICAL THERAPEUTICS.

The following pages will be especially devoted to the treatment and re-education of the returned soldier by other than medical or surgical means, or more properly, by physical measures. These antedate both medicine and surgery, and while generally supposed to belong to the laity, it must be remembered that no disease can be successfully combated or abnormal condition corrected either by medicine, surgery or physical therapy without first knowing the etiology, pathology, etc., of the disease or condition to be treated.

This then would bring physical therapy, as well as electro-therapy strictly within the confines of medicine, to be used only by the physician, or under his direct supervision.

I believe the government is honestly exerting itself to the utmost to rehabititate its returned mutilated heroes, and has spent immense amounts of money for equipment for that purpose. In many cases, however, the crippled soldier must return to his home and have his cure completed by the family physician, who knows but little of the physical measures that were heretofore employed.

Through the kind efforts of Maj. Frank B. Granger I have been able to enlist the valuable services of Leslie C. Sammons, M. D., organizer of clinics of the physiotherapeutical department of the army, who has written what follows in this volume, and which I feel certain will be welcomed, both by the general practitioner and the returned soldier he will be called upon to treat.

PHYSICAL THERAPEUTICS IN THE ARMY.

BY LESLIE C. SAMMONS, M. D.

When America entered the list of nations at war against Germany, it at once became apparent, judging by the experience of our allies, that we would not only lose a great many men by being killed in action and dying of disease, but what was of greater importance—economically speaking, and from the standpoint of the surgeon general—our number of wounded and disabled would be enormous.

Immediately the question arose as to what would be the greatest remedial value in restoring these men to a condition where they could be returned to their homes wage earners and actual producers, instead of sending them back to endure a life of suffering and become objects of pity and burdens upon their families and respective communities.

Here the surgeon general showed his wisdom and foresightedness by creating, after extended investigation, what became known as the reconstruction division, and chose that noted physician, Col. Frank Billings, of Chicago, to be the head. This was divided into two sections, viz:—that of occupational therapy, which has done most excellent work, but of which I will not speak, and the other the physio-therapy section, which has as its head Major Frank B. Granger, of Boston, then president of the American Association of Electro-Therapeutics and Radiology.

It is in this section and its work that we, as physicians, are most interested, and of which I will attempt to give you an outline. Major Granger at the outset had two most difficult problems facing him, that of enlisting doctors, who in civil life had some experience in the use of the various agencies embraced by physio-therapy, and the other to standardize and secure equipment. Both extremely difficult, requiring tact, good judgment and foresight. His position as president of the electro-therapeutical society had enabled him to obtain an extended acquaintance with men in this field, and also to know manufacturers of apparatus, and his years of actual experience had given him expert knowledge of the various types of apparatus and their relative value.

Physio-therapy was made to embrace electro-therapy, hydro-therapy, massage, medical exercise, mechano-therapy and the various kinds of heat and light, thus it may be seen that the field was broad, yet not intended or advanced as a "cure all" but to make use of the various natural agencies as an adjuvant to both the medical and surgical services. As the experience draws to a close skepticism, which at first was general in both of these services, has given way to a whole hearted support, and a call to the surgeon general from all the general military hospitals to have a department of this kind installed.

The writer had the honor to be appointed organizer of clinics and as such it became his duty to travel from hospital to hospital, organizing, installing and directing treatments. Thus it may be readily inferred the experience has been varied and valuable, covering as it does the treatment of many thousands of our soldiers.

The personnel of this department comprised the medical officer or officers in charge, an office force of enlisted men to keep records, enlisted men trained to give hydrotherapy and general massage treatments and reconstruction aids. The latter were young women, especially trained at such institutions as Harvard, Post Graduate Hospital of New York, Reed College of Portland and others. These reconstruction aids were given a course of intensive training, supervised by some of our most prominent orthopedists and neurologists, and were turned out highly expert in giving massage, and various medical exercises tending to overcome stiffened and ankylosed joints, loosen scar tissue, release muscular contractures, redevelop atrophied muscles and hasten regeneration of compressed and interrupted nerves.

Many a returned soldier is going to, and in many cases already does, owe his return to a life of usefulness to these competent and enthusiastic young women. Not only were they of value in a purely therapeutic way, but have contributed more than anyone else, in the hospitals where they have served, in keeping up the morale of the patients. When a patient is brought into a hospital and there waits two, three and sometimes four months until his wounds are healed, and often a long time thereafter, until the surgeon considers it prudent to do a bone graft operation or an operation to release or suture a severed nerve, he is quite apt and often does get into a condition of mind that he thinks nothing is being done for him. Just here the aids are of inestimable value, both in keeping the muscular tissues in such condition that the beneficial results of the operation may be facilitated and by her cheerful and optimistic association and a realization of the fact that something is actually being done for him, he begins to feel that he is not being neglected, but quite the opposite, someone is interested in him. His despondency is replaced by hope, expectancy and a determination to make the best of things, and each day he eagerly awaits her coming.

It is really marvellous what can be done in cases of ankylosis and badly adherent scars with the hands and fingers. A year ago I never would have believed it myself.

In the hydro-room the equipment consisted of one or more incandescent bath cabinets, leg and arm whirlpool baths, modern shower bath, control table of the Baruch Military type and the constant bath. Cases of arthritis, of which we had many, and the milder types of shell shock were put into the incandescent bath cabinet for ten to fifteen minutes, and then transferred to the circular needle shower for three to four minutes. Both the force and temperature of the water are under the absolute control of the operator, who sits at the control table twelve feet distant. The "Scotch douche" was then given as follows:

The control table was equipped with two short lengths of hose—eighteen inches to be exact—through one flowed hot water; through the other cold water, the temperature and pressure being regulated from the control table as stated above. The patients would be sprayed or douched first with the hot immediately followed by the cold, to the back, to each side and lastly to the front, which would be immediately followed by a fine pink glow of the skin. Sometimes this was followed by an alcohol rub or he might be put immediately to bed for an hour. It was surprising with what rapidity many of these cases responded to this treatment. The most rheumatic of this class of cases were treated by the hydro treatment and auto-condensation, each on alternate days, and I may say the percentage of poor results was so small as to be negligible. The more violent of these cases, in addition to the medical treatment administered in the neuro-psychiatric wards, were often given the constant bath, and it appeared to exert a decided sedative effect, and often was followed by a sleep that was difficult to obtain by other means.

With the arm or leg whirlpool baths we treated cases of sensitive joints and inflamed scars of the legs and arms. The therapeautic effect of this bath is due to the sudden changes in the temperature of the water—which is under control of the operator—and the massage of the tissues produced by the water being driven around rapidly by the air pressure. The concomitant hyperaemia and massage was productive of marked diminution of sensitiveness of the muscles. The work in the hydro-room, I may say, was done by trained male masseurs.

In this connection I will add that another class of cases, of which we had many hundreds, responded very well indeed to the same method of treatments as the milder war neuroses. I have reference to the cases of nervous exhaustion that were very prevalent as a sequela of the "Flu."

The modality that was no doubt most frequently called into use in the physio-therapy department was that of radiant heat, or as the ward surgeons were apt to term it for the sake of brevity, "baking." No doubt its use was abused, but it served admirably for the relief of pain, and, in many cases, for the promotion of granulation in unhealed wounds, producing hyperaemia in cases of ankylosis and as a preparatory treatment or measure preliminary to massage and exercise in scar tissue cases, muscular contractures and muscular atrophy. Usually a ten to twenty minute period of application of this modality was given in all these cases. It was also almost always a first thought in sprains and lumbagos, and the satisfaction resulting from its use was such that it was popular alike with both patient and the officer in charge.

Radiant heat was applied in a most convenient manner by means of three types of apparatus; a hand lamp, with reflector so constructed that parallel rays were shed upon the part under treatment; this type is known to the profession as the "Thermolyte." Another type was the four lamp outfit, so constructed as to be set over and adjusted to treat a hand, foot, part of leg or arm. A blanket was thrown over it to confine the heat. The other type was one large enough to be adjusted astride the patient's back, shoulders, hips, one or both legs, or likewise the front of his body, and a blanket thrown over it to confine the heat. This type had eight lamps, with a switch in circuit, so that only half of the lamps could be used or the whole number. This was made use of, not only in all the foregoing conditions, but in any case where diaphoresis was desired. In these "bakers" the old fashioned carbon filament lamp was most desirable, owing to its greater heat producing qualities.

The Violet ray, by means of focused arc lamps, was used in many of the larger hospitals, particularly those having many cases of amputation, where the stump was slow in healing, and in cases of discharging wounds. Here it seemed to me to be of great value in relieving the pain, stopping the discharge and hastening the closure of the wound. As to its use in the treatment of scar tissue cases my own experience is that it was not nearly so efficacious as the sodium chloride ionization, notwithstanding the claims of the others who advocate its use in these conditions; however, this might have been occasioned by faulty technique on my part. The technique employed in the stump cases was simple, the time of application and the distance depending on the size or area to be treated. If the lesion was large the lamp was placed at a distance of twenty inches for three minutes; smaller areas would require the lamp to be placed at a distance of two to three inches for twenty to forty seconds. This was also the technique employed in the discharging sinuses. We had no occasion to use this in cases of tuberculosis or many conditions other than those mentioned, but here the results were such that its use would be warranted in a more extended field.

Now we come to that physio-therapeutic agent, which, to my mind, is the most interesting of all. Interesting, perhaps, because of its many forms and the complicated technique involved. As one author has well said, "A terrible master, but a faithful and willing servant." I refer to the purely electrical modalities of galvanism, faradism, static, sinusoidal and high frequency, with their various combinations and forms of application.

The least of all used was the static, because of its sensitiveness to atmospheric influence and the unreliability of apparatus. In a place where up to 600 cases a day were treated, the apparatus must, of course, be of such a type that dependence be a prime requisite. The losing of charge and the foibles of atmospheric conditions must not be let interfere with a patient's treatments. Every patient was given a particular time and period of treatment and he had to be treated at that time and the schedule must not be disarranged by apparatus being out of commission.

However, in some of the hospitals the static was part of the equipment and many of my friends were enthusiastic, as the static man always is, and they undoubtedly did secure favorable results, which would not have been possible in places where I have been stationed, owing to the large number of patients to be treated and the delegating of the actual treatments to assistants, who administered them remarkably well, but could not be expected to serve as mechanical experts.

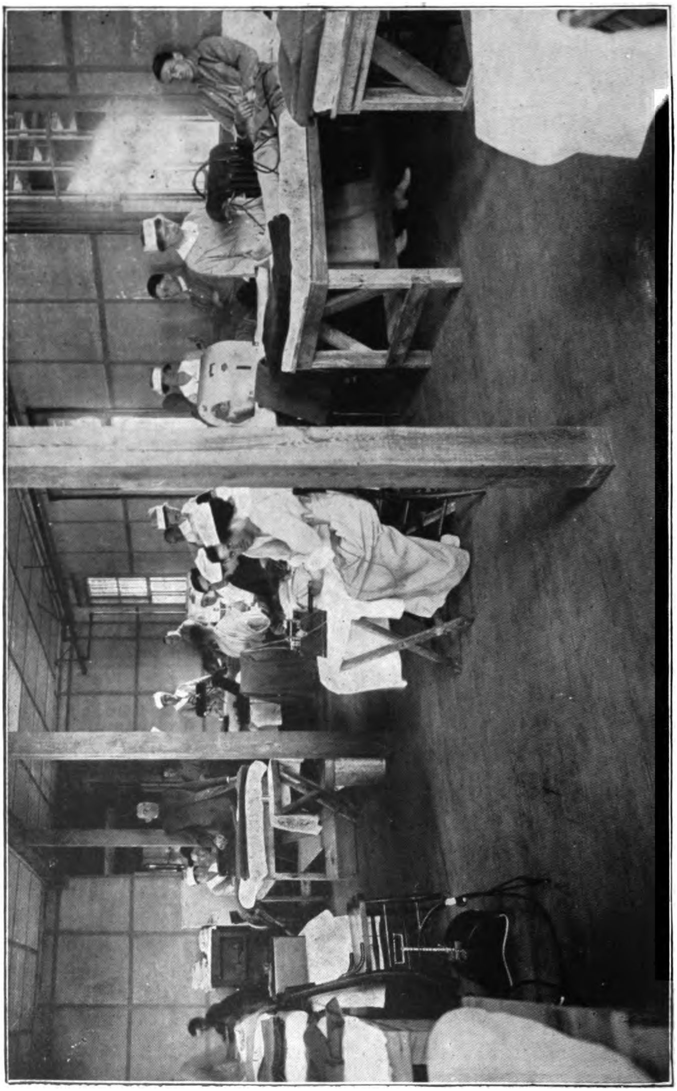
Personally, I think the one modality delivered by the static that accomplished the best results was the Morton wave, used in some of the cases of ankylosis and sacro-illiac strain.

I will speak first of the peripheral nerve injuries and their treatment by the electric current. I speak of these first because we had so many of them and it was interesting to watch the progress of nerve regeneration. The most common type was ulnar and median paralysis with wrist drop, and popliteal with foot drop, both of which was the result of GSW, which had by actual severance or cicatricial compression produced interruption, either in part or in whole.

In the cases of complete severance, the reaction of degeneration was almost always present and our technique here was the application daily of the slowly interrupted galvanic current to the motor points and muscles below the point of severance, for a period of about five minutes. In these cases there frequently would be no response for from two to four weeks, when all at once the aide giving the treatment and the patients themselves would be surprised and delighted to see a slight response; after which, from day to day, the progress would be so apparent that the usual form of greeting in the hospital or on the grounds would be, "Sir, see how I can move my finger now, or how I can straighten my fingers." In this connection we learned early the necessity of the patients wearing a cock-up splint to overcome the stronger antagonistic group of muscles. Where this procedure was followed, together with the indicated treatment, the results were all that could be wished for in fully 80% of the cases; the other 20% had nerve anastomosis operation, which was followed by the full physio-therapy treatment, electricity, massage and exercise. One group of these cases which could not be separated pathologically, for some reason did not respond to the faradic or galvanic currents, but showed splendid improvement when treated by the slow sinusoidal. It was a difficult matter to decide between the galvanic and sinusoidal in the treatment of these cases, so it became a matter of personal choice. There is no doubt in my mind, however, that the sinusoidal would have been preferred in many cases where the galvanic was used, but we experienced much difficulty in obtaining a sufficient number of sinusoidal machines. When a case had progressed to the point where the induction current would elicit a response or contraction, then this modality was used until the regeneration was complete. Where the unusual occurred, as it did in some of the cases, was when the motor function returned and the sensory was unaffected, then we used the high frequency with considerable benefit in restoration of sensation.

By the diagnostic use of the current we were able to tell from time to time just how far the nerve had regenerated. We usually did this as a matter of routine every week, and it was interesting to note the comparatively uniform extent of repair. Certainly the current was of exceeding value if for no other purpose than that of diagnosis. The neurologist could not have gotten along without it, and its therapeutic value is now unquestioned.

Naturally, where there was nerve interruption, there was muscular atrophy and trophic changes. The current



Corner of Radiant Heat, Massage and Muscle Training Department. Department gives 1,800 treatments per day.

and massage did more than anything else to promote muscular cell growth and consequently had much to do with physiological nerve changes.

I have been speaking of the cases of actual nerve severance, but the greatest number came from compression by scar tissue. These cases responded very rapidly, except where the scar was very dense and had to be dissected by the surgeon.

Practically all these cases at some time during their hospital stay came into the physio-therapy department, where treatment was prescribed and administered. The first thought was to so soften the scar that massage and exercise would avail in releasing contracted muscles. This was done in two ways: by ionization and the violet ray. The ionization was the more effective, though it had the disadvantage of requiring longer time for each treatment, and the time was an important factor.

The technique used was to saturate several thicknesses of gauze with a saturated solution of sodium chloride and cover the scar evenly and smoothly with the wet gauze and a piece of block tin, nearly the same size as the gauze, connected to the negative side of the galvanic, and firmly bound over the area, while the positive pole was connected as nearly opposite as convenient, and current to toleration was permitted to pass for twenty minutes daily.

This was attended with an apparent liquification of the tough scar. Each seance was completed by ten minutes of massage and exercise. Results were plainly apparent in three weeks, or none was to be expected from further treatment, when the case was referred to the neuro-surgical service for further examination relative to suturing. I believe I am on the conservative side when I say that not more than 20% of the cases that had physio-therapy treatment were not benefited and operation was resorted to. Many times have we been astonished to see a large, dense and badly adherent scar soften in two weeks, when we really thought it a waste of time to use ionization.

In speaking of the relative value of the galvanic and sinusoidal currents, it would be difficult and most inaccurate to make the bold statement that greater benefits were derived from one than from the other, but theoretically speaking one would be pardoned for concluding that the sinusoidal would do the most good in hastening regeneration of a nerve, combining as it does the chemical action of the galvanic and the mechanical of the faradic. This is not borne out either in practice or on more deliberate consideration, but the fact that it is an ideal massage and produces the best muscular contraction with the least intensity recommends it in this kind of work.

The indications for electrical treatment in nerve work are that it does, or tends to do, three things, viz.: maintain contractibility of the muscles that are affected, accelerate regeneration and soothe pain, if any is present

The precautions are that only a moderate effort be required of the paralyzed muscle, that is, only a few contractions be had daily, the seance, as before mentioned, being short and not of too great an intensity.

At the start the neurologist, or many of them, knew little or nothing of the sinusoidal, but now that such splendid results have been obtained they are apt to peremptorily order cases to be given sinusoidal treatment without knowing anything of the physics of this modality.

At the start, and even yet, much damage has been done by this current, for the reason that the applications are continued for too long a time. It must be remembered that the impulse to contract these muscles is not sent out from the brain—they are involuntary—and the brain is not cognizant of how much work they are doing. The battery is easy to use, the muscular contractions are painless, and I have known operators to forget the patient for a time and turn to something else, leaving these muscles to relax and contract violently for twenty to thirty minutes. This could, and did do an immense amount of damage. The muscle being disturbed in its nutrition would tend to atrophy by this long continued excitation.

Peripheral nerve injuries covered our largest number of cases, and as I have said, were the most interesting; second to them, both in number and interest, were the ankyloses, caused by G. S. W., disuse from long constraint in a cast or splint, arthritis and fractures. These cases invariably found their way to the physio-therapy department very soon after their entrance into the reconstruction hospital, and here we made quite a reputation for ourselves, both with the patients themselves and the ward surgeons. Almost invariably those of a fibrous character were made useful in a very short time; while those of bony ankylosis were more stubborn and the benefit derived from any source was limited.

The plan of treatment of these cases, so far as the application of the current was concerned, was a choice of three modalities, as follows: Diathermy was first choice by almost every physio-therapist, both from the standpoint of reliability of the apparatus and from the results obtained where it was reasonable to expect results from anything.

The technique was the usual one with this modality, of taking a piece of pliable block tin or heavy tin foil, cut to any size that the judgment of the operator and the area to be treated demanded, and applying one to each side of the joint, firmly in contact with the skin, and these in turn connected one to each side of the apparatus, and the spark gap opened to the first step, or until the milliammeter registered about 400. Here it was held for four or five minutes, when the spark was opened up until, in the judgment of the person applying it and proportionate with the area between the electrodes, current of from 500 to 2000 milliamperes was maintained for a period of from 15 to 20 minutes. When the application was completed the area involved would seem to be very hyperæmic and bathed in a profuse perspiration. Now the patient was turned over to an aide, who would massage and give constant, graduated exercise to the articulation. The technique employed was practically the same for all joints, with the exception that the larger ones demanded more amperage and consequently larger electrodes than the smaller ones. Usually after the patient had received ten such treatments, the ease with which flexion and extension were performed was very gratifying. The joints most commonly involved were the shoulders, elbows, wrists, knees and ankles, our results were best with the knees and elbows.

Another method used in these cases was ionization, after the Leduc plan, exactly as we did with the scar tissue cases and with the same medicament. We, however, made use of this more often for the smaller joints, where diathermy was more difficult of application. The results were good, but not nearly to the extent as was diathermy.

As I mentioned before, some of these cases were treated by the Morton wave current from the static machine. The technique being the usual one with that current, but the results were much inferior to diathermy and exercise.

Just here I want to mention, with reference to the dissolving of scar tissue, that during the last month I made use of a medicament that, while it is an old one, I have not heard of any one of the other physio-therapists using in the army. I have reference to the use of thiosinamine. I used this where I had formerly been using sodium chloride, and I thought that the results were more rapidly attained with its use than with the former. The method of using it was to make an isotinic solution by the addition of glycerin and sodium chloride and introduce it into the scar from the positive pole instead of from the negative as with the sodium solution.

There was one condition that tried the patience and skill of surgeons everywhere, and military surgeons were as sorely tried as any others. Many surgeons have all but lost their reputation in combating osteo myelitis. Clean surgery and the Dakin treatment no doubt has accomplished more than anything else. Almost every surgeon you meet has some pet method of treating osteomyelitis, and even now a prominent foreign surgeon is in this country with his staff trying to tell our surgeons that his operation has met with more decided results than anything else, but this remains to be seen. Every hospital that you go through has many of these cases that have been in their wards for months. In view of this unsettled state with reference to this disease we felt justified in giving physio-therapy a trial, and, while the results were not brilliant, they certainly compare favorably with the best results of the surgeons, and I am certain was worth while.

The modality made use of here again was diathermy, and I believe it greatly aided in the proliferation of new cells. The complete procedure was first, whatever operative measures that were considered wise, then the Dakin treatment, and when the wound was nearly or quite healed we subjected the area to the ultra violet ray to complete the healing; then came diathermy, with its heat penetration, to improve the circulation and promote new bone cell growth.

I have in mind one case in particular that I will cite you. Cadet B, 10th Aero Squadron, aged 23, G. S. W. right scapula. A number of operations had been performed by a prominent surgeon. In hospital eight months; wound closed except very small sinus. X-ray showed complete destruction of all the scapula below the spine. This man did not get the ultra violet ray (we had no lamp there) but did get the diathermy every day, and after the third week the X-ray showed continued extension of new growth, and when I left that hospital after nearly three months' stay, the patient was going into the city and walking about at will, with arm hanging at his side only supported by a sling. He was free from all pain and tenderness except on deep pressure. In fact every indication pointed to a complete recovery. Perhaps he would have secured such a result without diathermy, but you never could make him believe it. This is the only case that I had the privilege of following so nearly through to recovery, but I have treated a number in a similar manner and the relief from pain and soreness in practically all of them was marked.

As may be imagined where there were so many cases of fracture, we had many cases of non-union and bad callus. We undoubtedly did much for these patients. I have in mind several where the use of diathermy made unnecessary a secondary operation to apply Lane's splints or bone graft. It was my pleasure, and added much to my experience, to have been a number of weeks stationed at the same hospital as Major Fred Albee, of "bone graft" fame, and one case at that hospital is very fresh in my mind, in which there was only fibrous union and very little of that. There was fracture of the tibia and fibula at the middle third from G. S. W. Diathermy was used, and after two weeks of daily treatment, there was a gradual stiffening at the seat of fracture and the X-ray showed repeatedly the formation of callus. The last I knew of this patient he was out delivering Victory loan speeches, walking on both legs and without operative interference of any sort. At the first Major Albee felt very sure that a bone graft would have to be done. There is no doubt in my mind that the heat penetration produced such an influx of blood to the part that new growth was stimulated. With the large ugly calluses it was comparatively easy to reduce, and the pain which was present in many of them was only a matter of a short period of treatment.

During the last three years of civil practice we had experienced an ever increasing number of cases of neuritis. Here they were almost altogether from some focal infection. In the army we not only had these, but a vast number the result of trauma. In no wise did the physio-therapeutic treatment differ for the relief of pain and the subduing of the inflammation. I had obtained in the pre-war period such satisfying results in these cases from a combination current that I did not hesitate to use it in those of traumatic origin, and the results were fully as satisfactory. The relief from pain after a very few treatments was especially gratifying to those afflicted, and only those who have had this painful condition can appreciate absolute freedom from pain.

The current used was a combination of the sinusoidal and galvanic obtained from a Polysine generator. The method of using it was to apply one electrode at the proximal and one at the distal end of pain radiation, and the intensity of the current was to toleration and the length of application forty minutes, an hour would be better.

Occassionally we used in these painful conditions the pencil discharge from the static. This gave quite good results in some cases, but quite a good many did not respond to any appreciable extent, which was not true with the first modality.

As has been stated before, we often used the electric current for neurasthenia in connection with the hydro treatment. The one of choice in treating this condition was, every other day high frequency auto-condensation for a period of from twelve to fifteen minutes. The sedation was so marked that with many of them, I have seen sleepless, irritable, grouchy patients go to sleep on the table while taking treatment. These were the mild types of shell shock or war neuroses.

Muscular atrophy was another common condition that demanded attention. We had this condition concurrent with the peripheral nerve injuries and we had them as a distinct entity, the result of long confinement in a cast or splint. These we spoke of as atrophy from disuse. As there were so many fractures, both from gun shot wounds received in France and from the camp accidents at home, there were many casts and splints used, and as four to eight weeks of such constraint did not conduce to muscular development, the result, when the appliance was at last removed, was very apparent. All these cases were referred to us for treatment. The prescription for these usually read, massage, exercise and some form of faradic stimulation. This most often was given by a good faradic coil and directed to the muscles affected. In the cases thus treated the period of convalescence was shortened and likewise his stay in the hospital. The moral to be derived from these cases is, early removal of the cast, massage and passive motion employed.

Another class of cases, fairly common in civil practice, that we had quite a number of were those of facial palsy. One splendid authority, with whom I have had many arguments, contends that if left alone they get well anyhow. I contend that if left alone, if they do get well, it takes a very much longer time, and I am in doubt of it with some of them. But be that as it may, we treated them in the physio-therapy department and we feel that we greatly hastened the restoration of function. The modality that gave us our very best results and in the quickest time, was the slow sinusoidal, one large electrode applied to the nape of the neck or between the scapulæ and the other small electrode to the motor points on the side of the face affected. It did not take many treatments until some voluntary movements were obtained, from which time the return to full voluntary control was quite rapid.

At one hospital where I was stationed, we were called upon to do something for about a dozen old polio cases that had been in the wards for months, one in particular a year and a half. These were interesting, but tedious and stubborn, and sometimes your efforts were unavailing. The result in a few of them was so brilliant that we were spurred on to do our best for all of them, in the hope that we would finally get some response.

The treatment that was resorted to in the effort to restore these men to some degree of comfort, and I may say the only one that we did get anything from was the daily use of the slow or surging sinusoidal, with one large electrode over the lumbo-sacral region and the other small electrode over the motor points of the extremities, only a few being stimulated each day. Here again the seances were of short duration. This electric stimulation was followed by massage and exercise. One case that had been a patient and helpless in bed when we began to treat him was walking on two canes and the happiest man I have ever seen when I left there after a stay of nearly three months.

Another class of cases, the result of modern warfare was the so-called "trench feet." These were very stubborn and required long and constant treatment no matter what kind was used. I think that perhaps we secured the best results from radiant heat and the ultra violet ray. When the ray was used it had to be long enough to get a decided reaction. These feet were horrible looking things and many of them decidedly repulsive. We also treated many of them with the whirlpool baths and some of them responded to this treatment very well, but, as I have said, the very best results were obtained with the ultra violet ray.

Sciaticas were a common war sequela, some acute and some decidedly chronic. Some undoubtedly traumatic in origin and some of no origin, or at least none could be found, and they were a constant source of annoyance to the ward surgeons, as they always are to the general practitioner. It has been said that one of the first things one must learn to do in the army is to "pass the buck" and here, as in many other instances, the physio-therapy department was the place it was passed to, and it was up to us to do something for these cases, or have them left on our hands, as we could not pass him on to anyone else. In quite a number of these cases we secured some very handsome results, by the use of the same treatment that was employed in the cases of neuritis and by the long continued application of radiant heat. In the management of some of the old chronic cases of this trouble I saw a treatment used in connection with physio-therapy that is as nearly specific as anything that I have ever seen in medicine. While in Texas we had there for a short time one of our most prominent neurologists, and he gave epidural injections to about fifteen of these old cases and at the same time ordered the use of radiant heat for them, and the results were absolutely marvelous.

One case in particular that I well remember was Sergeant Gilbert, aged 22, Trooper. Diagnosis—sciatica and diverticulitis; six months without being free from pain and last four confined to bed. Carried to operating room on litter; injected by this method; next morning given thirty minute application of radiant heat; next morning following heat application was up and shaved himself. Made complete recovery, and when I left was learning auto mechanics. I mention this case to illustrate that the war has demonstrated physio-therapy is a ready help to both medicine and surgery, and should not be heralded as a panacea for all the ills of the human race, but is of great benefit in its legitimate sphere, and when intelligently applied.

No. 1.

No. 1. Private F. A., admitted to hospital 5/21/19. GSW, compound, comminuted fracture middle third, right femur with deformity and non-union. Treatment: Diathermy and light massage daily. 6/20/19 careful examination showed surprisingly rapid growth and considerable union at point of fracture.